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The Right Honourable the EARL OF RAVENSWORTH in the Chair.

## NAVAL INTELLIGENCE AND PROTECTION OF COMMERCE IN WAR.

By Captain J. C. R. Colomb, F.R.G.S., F.S.S.

Having been asked by this Institution to deliver a lecture on the above subject, I think it my duty to do so. Though sensible of the honour conferred by repeated invitations, several considerations deterred me from at once accepting them; even now I am doubtful as to the wisdom of compliance. It is a grave question whether so wide a problem can be adequately treated in one short hour, and whether a matter of the most serious national concern can be publicly discussed without more danger of directing foreign attention to our deficiencies and difficulties than hope of remedy and removal by ourselves. Public opinion will not apparently turn out of the current of ever-changing, but now, always purely military, theories of insular defence requirements, to a calm, quiet contemplation of the grim realities of modern maritime war to a people dependent on the sea for daily bread. The rapid and increasing diversion of English thought out of the great, broad channels of actual and real national requirements, into little whirlpools and back eddies of abstract military experiments, is to be deplored; it is not, however, to be wondered at. Every volunteer from the Land's End to the Orkneys, every militiaman from Dover to Donegal, is the apostle of a purely insular theory of defence, the practical preacher of *purely* military precautions; Russell, from nearly all battle-fields of modern times; Hozier, from "the Mountains of Rasselas;" Brackenbury, from the plains of Italy; and Forbes, from the ruins of Sedan, have so stirred the heart of England that her head has well nigh ceased to regard the influence of water as practically ruling the whole principle of her own and that of her Empire's defence. No eloquent descriptions of tactical struggles for strategical positions have yet been dated from "equatorial crossings," or from "off Cape Horn;" no great populations at centres of manufacturing industries in the very heart of England have been thrown out of work by far distant war operations against us interfering with the supply lines of raw material; hunger

pangs have not been felt by multitudes through the capture of grain vessels, or by that rise in insurance to cover war risks which will certainly be in direct ratio to the organization, adaptation, and sufficiency of the pre-arranged defence of our sea-lines all over the globe.

Every School Board boy in the United Kingdom has some notions, however vague, relative to soldiers and invasion, but millions of intelligent grown-up Englishmen to-day have no distinct views at all as to the defence of the sea. They dream that that matter was settled once and for all by the victory of Trafalgar, if not by the defeat of the Spanish Armada. Yet, only by methodical, complete, and Imperial pre-arrangements, can England, in days of steam and huge commerce, face maritime war without dread, or hope to emerge from it without disaster. An Empire having thousands of vessels counting millions of tons, annually carrying to and from every corner of the world, its goods in value approaching a thousand millions sterling, cannot hope to localize her naval wars; nor can it be for one moment assumed that a maritime position so constituted and of such extent, can be defended simply by individual skill or even genius of naval Commanders. War fleets must be separated by long sea intervals; however efficient they may be, they are but as flies on the great commercial wheels revolving round the world. They can provide but small security to sea-lines of thousands upon thousands of miles in length, unless they act in combination and are subordinated to a general carefully prepared and preconcerted plan. I shall presently produce some broad facts which it is to be hoped will sufficiently establish the absolute necessity for more public attention being directed to this matter. I shall submit some calculations as to the actual money value of the various divisions of oceans to England and her Empire; I shall do so merely to illustrate relatively what is past all price, viz., the practical, social, and indeed the life and death consequences involved to the English race in the precautions taken for securing in war the safety and freedom of the sea. It is not too much to say that the loss of a whole British Army on Continental battle-fields could not of itself produce the catastrophe sure to follow as a direct and immediate consequence on the interruption of even one of our main sea-lines of supply. One would cause mental anguish and a fall in the Funds, the other would add to these, physical suffering by a rise in bread. The forcible curtailment of *imports* of grain and raw material, and of the *exports* of manufactured articles, means a cry from millions, for bread which could not be given, for work which could not be obtained. No one who hears me or who reads this paper is without influence. Be it little or great, all have some, and my reason for coming here to-day is to appeal for the exercise of that influence to turn attention more towards a true realization of the primary requirements consequent upon our Empire's exceptional position, and to the pre-arrangements necessary for their adequate and complete fulfilment. The few words I think it desirable to say may, I hope, be of some slight use to those whose influence cannot be without some result. That great multitude of Englishmen who sway the defensive policy of our Empire, know nothing at all of what England at war

with even one Great Power means in days of steam and gigantic commerce; and while some are enthusiastic about every detail of the last military experiment, nearly all seem placidly content to trust to luck and some powerful ironclads, to make everything quite safe and easy for us on the sea.

It seems to me desirable to make these prefatory, if somewhat personal, remarks, because every year's consideration of this and similar subjects, on which I have so often spoken in this theatre, increases my sense of its awful importance, and, therefore, of the grave responsibility incurred in the method in which it is submitted for discussion and publication. Sixteen years ago I fancied it possible some good might come of venturing to write and speak on these questions, differing as I then did, and do now, with the popular view of the aspects of British defence. Now, finding myself only beginning to approach the verges of true knowledge of its depth, I fear it is more likely such slender contributions to the literature of so great a subject may do more harm than good.

Having thus explained my sense of responsibility, and my reason for overcoming a disinclination to incur it, I proceed to submit some general observations on the necessity for establishing an organized and far-reaching system of naval intelligence.

### *The Scope of Naval Intelligence.*

Naval intelligence comprehends within its scope a vast number of subjects widely different in their nature, but in their several orbits controlled by one great general consideration, viz., the efficiency and adaptation of our naval means to the work to be done in war. Now the two main conditions to be fulfilled by the Naval Service are the closing up of our enemy's ports and the protection of our own commerce on the high seas from depredations. Attacks on the high seas will be made by hostile cruizers which may elude the vigilance of blockading fleets, or by vessels purchased, fitted out, and armed in rear of our fleets, perhaps thousands of miles away from the blockaded coasts. It is to be observed that while the extent of the enemy's seaboard limits the operations of blockade, the area of operations for the direct protection of our commerce has, in a geographical sense, practically no limits at all. While I am speaking, British smoke from British coal burning in British steamers, carrying *foreign* food to British mouths, material to British manufactories, and goods to British warehouses, is blackening the airs of the tropic, the temperate, and even of the arctic zones. At this moment British sails are being blown away in dreary morning watch kept by British seamen at the antipodes, are idly flapping in the regions of calms in both hemispheres, and being frozen stiff in arctic, and even in antarctic, seas.

As naval operations may be grouped under two great heads, so naval intelligence may be classified in two divisions—one referring to blockade, the other to the direct protection of commerce. The broadest difference between the sort of "intelligence," essentially necessary to success in undertaking either operation, appears to me to be this—that in one case what is most required is knowledge of your

enemy's position; in the other, knowledge of your own. In both cases success will relatively depend on knowledge, down to the smallest detail, of the work to be done. The operations of blockade are carried on against a seaboard fixed and invariable, and against naval and military appliances wielded under one direction, for a distinct and settled war purpose. The conditions which determine operations for the direct defence of sea-commerce are almost the reverse. The carrying trade to be protected is not fixed, it varies with circumstances, both in direction and value, and is the visible resultant of many thousand busy minds, working ceaselessly in all parts of the globe by many thousand processes for individual peaceful objects. These objects defy the control of war policies and war ministers, for they are only attainable by obedience to the eternal laws of supply and demand. These laws have survived the Tyrian, Carthaginian, Venetian, Spanish, and Dutch sea supremacies, and will survive so long as business in the world is done. Those who think that the movements of British commerce could be made to conform to arrangements for its protection by convoy war-ships should really picture the scenes "on 'Change" in London, Manchester, Liverpool, and hundreds of business centres in England, to say nothing of Sydney, Montreal, Melbourne, Calcutta, Cape Town, &c., which would follow the posting up of an Admiralty notification that "the Imperial sea-roads were so interrupted that "arrangements were under immediate consideration to provide, so far as "means would permit, convoy protection for eight hundred millions' "worth of exports and imports, and the entry, clearance, and safe pas-"sage of several million tons of British shipping from and to ports on "every sea and ocean in the world." The figures I offer as a stippling-in of the background of the pictures, because they are founded on the official returns for last year. The time would then, I think, have come for the operations of invasion to be wholly unnecessary for our complete subjugation. Our Volunteer Army would not then need a commissariat department, because nearly one-half our home Army, as well as civil population, would have no food. The burning question which exercises some minds now as to whether our militia shall wear gold or silver lace would then lose much of its point. It is very desirable to keep clearly in view the broad issues of great national defence questions, and I specially allude to the one of convoys, not as a matter to be settled in a "ten minutes" discussion, but for patient calculation and serious study. Were naval Officers afforded by the nation, as they should be, opportunities of studying, as part of their superior professional training, the directions and variations of that huge commerce, the safety of which in war will be committed to their keeping, I confess I think systems of naval intelligence and principles of sea strategy would replace, more or less, vague national ideas as to convoys. But, be it observed, England affords her naval Officers no such opportunity.

*Varieties of Subjects with which Naval Intelligence has to deal.*

A vast number of subjects are embraced under the term "naval "intelligence," some common to both divisions before mentioned, others specially or more closely connected with one rather than the other. I

can, however, in the time only glance at some of the principal ones. Those common to both relate to hydrography, meteorology, the naval policies and arrangements of foreign nations as indicated by the war-vessels they build or buy, the material resources, active or dormant, of maritime nations, both as regards construction, refitment, and maintenance. The principles and details of construction, armament, machinery, appliances, and efficiencies or deficiencies of their war-ships; all matters relating to the *personnel*, both active and reserve, of their war navies. These headings sufficiently indicate what may be considered common to both branches of naval intelligence.

Special to blockade are—topography of coast and river districts,[1] embracing detailed information respecting railway and canal communications of war and mercantile ports. Railways may afford facilities for moving fleets of efficient torpedo-boats from one port to another more rapidly than water permits a blockading force to do, and it is reasonable to suppose an effort to raise the blockade of a port would be developed through a cloud of torpedo-boats. The relative power of concentration possessed by the blockaders and the blockaded must exercise considerable influence on the strategical distribution of the blockading force. Railway and canal communications may also to some extent affect the question of fuel supplies of the blockaded. As my intention is to refer almost exclusively to the direct protection of commerce on the high seas, I am compelled to refrain from closer consideration of intelligence having reference to blockade. There are, however, one or two general reflections worthy of special remark.

As regards hydrographical information, the experience of maritime nations testifies to the care and completeness exercised by our Admiralty in its collection, so far as oceans or seas are concerned. But it is doubtful whether we know as much as we ought to know about great rivers, such, for example, as the Amur, with its 583,000 square miles of hydrographic basin. No doubt the Military Intelligence Department in Pall Mall collects a certain amount of information respecting these, but military men know nothing of the naval aspects of the great rivers and their naval resources.

The short story I told in a former paper[2] here of the building and work done by the little Russian steamer "Aigun," in 1854, on the Amur, is a sufficient warning to us not to neglect the existence or development of naval resources many hundred miles from the coast lines. Obviously a naval, not a military, department should collect such intelligence, and divided responsibility should be avoided.

Respecting the policy, resources, the principles and details of construction, armament, appliances, and *personnel*, and that great host of matters and things which go to make up visible naval war power, I, for one, feel confident that our Admiralty struggles hard to obtain complete foreign information with the *miserably scanty means* provided by the country for collecting it. It is a noteworthy fact that, while

[1] See valuable paper on "Tactics of Blockade," by Captain S. Long, R.N., in the Journal, vol. xxv, No. CX, page 316 *et seq.*

[2] See "Russian Development and our Naval and Military Position in the North "Pacific," Journal, vol. xxiii, No. CI.

we have a great military "Intelligence" Department, and besides have a Military Attaché at the Courts of the Great Powers, we are quite content that one solitary naval Officer should be charged with watching the naval developments and preparations of the whole of Europe! Yet invasions cannot be attempted, nor can we move even a drummer-boy beyond our shores without a naval operation, great or small, being the primary step of military movements so far as we are concerned. Under the heads mentioned there is a great variety of information respecting foreign navies, which could, with great propriety, and *should*, I venture to think, be given by our Admiralty to naval Officers who have now no means whatever of obtaining authoritative information, and who, therefore, will be in war entirely ignorant of much they ought to know.

As regards seaboard topography, railway and canal communications, of ports, &c., such intelligence is, I believe, collected by the military department; but practical experience of war generally proves that sources of failure are most often found between the chinks of divided responsibility. The very startling announcement made a few weeks ago in the House of Commons, "there could be no doubt the naval "guns of England's fleet are inferior to the new guns on board the "German, French, and Russian ships."[1] has been received by the country with comfortable complacency. It would be plunged in a state of excited indignation had it been asserted instead that the rifles of the Army were, without doubt, inferior to those of the same foreign Powers; but, as regards naval guns, it neither recognizes the seriousness of the fact, nor reflects that it is the natural result of divided responsibility. When we are at war there will be probably twenty heavy guns brought into action on the sea for every one on land, yet the manufacture and preponderating opinion controlling the construction and fittings of naval ordnance is vested in those who cannot fight them on the sea, and under the direction of a military department, knowing nothing practically of sea warfare. The Admiralty, which is directly responsible to the nation for the efficiency of everything appertaining to the fleet, has not direct control of its own ordnance. Nor is there any reason why the Admiralty should not itself collect intelligence in this matter of military seaboard topography, having, as it has, qualified Officers available for this service. Why should Marine Artillery Officers be employed as professors at the Staff and Military Colleges instructing military students in military art, while the Admiralty has to rely on the War Office for such topographical information as is necessary for naval operations on an enemy's seaboard?

I mention these things, not because, as all my former writings will amply testify, I either underrate or undervalue the great and grave importance of the military arms of England, not because I do not feel as thoroughly as anyone the necessity for purely military Intelligence Departments,[2] but because it is my endeavour to look beyond popular

[1] *Vide* speech of the Right Honourable W. H. Smith, M.P., in debate on Navy Estimates, 1881.

[2] Besides the department under the War Office at home, there is also one in India.

fancies and natural professional leanings, and to state plainly matters of fact as they appear to me. In dismissing from further examination naval intelligence in its general aspects or in the special aspects of blockade, I would submit that it would appear that while advancing science and modern appliances in no way diminish the absolute necessity of blockading an enemy's seaboard as the first step towards protecting commerce, they do diminish the probability of making a blockade effectual and complete; and in proportion as such probability is reduced so must increased precautions be taken for the direct defence of commerce on the high seas. It is now to this main portion of my subject all further remark will exclusively apply.

*Naval Intelligence in Relation to the Protection of Commerce.*

Under this head the intelligence required is—

1. The general laws which, under normal conditions, govern the distribution of British sea commerce over the world, both as regards time, place, and value.

2. The particular influences which any particular wars are likely to produce on the direction and value of British commerce passing over different sea-lines. The blockading of a coast, for example, would prevent the laws of supply and demand being satisfied by means of sea communications terminating on that seaboard; the imports which would otherwise have been absorbed by the ports blockaded will, to a greater or less degree, according to circumstances, seek other markets and be diverted into new channels,[1] thus causing a variation in direction and value of sea-commerce.

3. The careful and continuous observation of the development and resources of grain-producing lands, the periods of the harvests, and the visible supplies available for export.

I have so often dwelt on the all-important question of the critical position of the food supply of the United Kingdom in war, that I cannot stop now to add very much to what I have previously stated, except in a general way. We have Mr. John Bright's authority that between 1879 and 1880 "out of every four loaves of bread eaten by "the people of the United Kingdom three loaves came from abroad";[2] in other words, over the sea.[3] Had we been at war during that period, therefore, whether the three loaves ever reached the mouths of our population would have been a matter entirely dependent on our naval means of protection, and on the accuracy of our naval intelligence.

[1] The war in the United States furnished an example: as the "Southern States "did not draw down the usual suppy of grain from the Northern," grain had to seek another market, the result being that it found its way to the United Kingdom, and to use the phrase of a commercial journal of 1863, "put out of gear the cycle of "high to low prices." The same journal goes on to say, "Whatever injury America "has inflicted upon this country by the blockade, we must count the enormous sup- "plies of grain which she poured into our ports last year as some compensation." One effect of the war was to cause the Northern States to send us a great increase of bread, and to draw from us a great increase of lead.

[2] See his letter dated 18th March, 1881.

[3] I give Mr. John Bright's statement, because his words carry such weight In this case, however, he has overstated facts as to the proportion of foreign and home bread consumed.—J. C. R. C.

I would here point out that the geographical position of the source of our main supply has, within the last few years, shifted several thousand miles from east to west, from the districts of the Euxine to the Western States of America.[1] The direction, length, and value of our food lines has recently entirely changed, and that change will influence our naval arrangements in war. I have often seen discussions of a purely naval or military character based on the assumption of a war with the States. I would, however, beg you to look beyond the professional limits of such a supposition to the great national question of its present practical impossibility. We are at present dependent on the States for an enormous proportion of our food, and the British Empire, possessing grain-producing lands, now lying idle, yet capable, if populated and developed, of feeding hundreds of millions of human beings, could hardly resist the will of the States, because misery and starvation of the masses would reign in England, as a direct consequence of attempting to do so. But there is yet another great change impending in the sources of food supply. Thanks to the energy of Canada, with a population rather less than that of London, the construction of a British Pacific Railway has begun in earnest. Before long our food supplies may be grown under our own flag.[2] It would not be difficult to show that in war this railway, with its attendant and possible results, would give our naval position greater strategical security and strength than an extra half dozen "Inflexibles."

4. Next comes the collection of information and continuous observation of the direction of coal exports from England and her colonies, also from such countries as export coal for steam sea traffic, the average supply and demand, and the ratio of increase at all British and foreign coaling places. As a Royal Commission has been sitting for nearly two years, charged with the special consideration of the state and defences of our coaling stations, I will not make further reference to them, and for the first time out of the many I have spoken from this place, it is satisfactory that such public action in the matter enables me to do so.

5. Next, the details of construction and speed of every merchant steamer in the world possessing power and capacity for adaptation as a war cruizer of attack, should be carefully and continuously collected.[3] The nature of ordinary peace employment, and the ownership should be known, no matter under what flag she sails. The transfer of such vessels from one flag to another, is the operation of minutes only, involving private arrangements, payment of money, and the signing of names. The Peruvian vessels, for example, were so transferred the other day by private enterprise, to the flags of Germany and Russia. The whereabouts and movements from port to port, of all foreign steamers capable of conversion into efficient

[1] It is remarkable that the Turkish troops at Volo were the other day supplied with bread stuffs from the States.

[2] The imports of grain coming as part cargo in steamers from Australia is steadily increasing, but such supply is but a drop in the great ocean of our food demand.

[3] To some this may appear beyond the scope of what is practically possible. It should, however, be remembered the enormous interests at stake; and further, that there are not so very many steamers under foreign flags suitable for conversion into

weapons of attack, should be at all times known at our Admiralty, and so far as is practically possible, by Admirals commanding abroad. It is only by the most plodding methodical daily collection and digestion of such intelligence during peace, that we shall on the outbreak of war avoid surprises by the issuing from unexpected and unobserved quarters of cruizers bought at one place, armed and equipped at another, and destroying our commerce somewhere else. Were our system of naval intelligence as complete and as far-reaching as the necessities of our huge commercial interest require, we *should* be able to prevent most of such vessels getting to sea on errands hostile to us: either by our immediate purchase of all such as are suitable for conversion, from owners who can be tempted to sell, or, if outwitted in this by our enemy's agents, then by shutting the vessels up in port.

No nation with its direct sea route stopped by blockade will long continue to purchase merchant steamers for conversion into armed cruizers, if the result be that most of them rot in the neutral ports, owing to the efficiency of a British Naval Intelligence Department unceasingly but quietly at work, and the careful attention of British ships of war which, from the very commencement of hostilities, if not before, dog suspicious characters from port to port. They must have speed, staying power, and strength enough to do so. We are now trusting to our material resources, and the mere possession of great national wealth, to save our commerce somehow or other in the hour of its peril; but if we do not use our national brains, even to the extent of recognizing the necessity for establishing a great and far-reaching system of naval intelligence, that peril when it comes will, I venture to think, speedily terminate in the ruin of our carrying trade. It is the very first stage, rather than the closing scenes of maritime war, which decides the fate of such trade. American war fleets floated triumphant on the sea long after the American carrying trade—terrified by ocean fires kindled by an uncaught "Alabama"—had taken to itself wings and fled.[1] Moral effect is the great force to be reckoned with in considering the protection of commerce. If the first few weeks of war shakes that ignorance which blindly hopes that our naval

efficient war cruizers. We own about two-thirds of the steam tonnage of the world, the total (gross) of which is in round numbers 6,700,000 tons.

The following is a sufficient illustration of its distribution :—

| | |
|---|---|
| Under British flag | 4,200,000 tons. |
| " American flag | 630,000 " |
| " French " | 420,000 " |
| " German " | 290,000 " |
| " Spanish " | 200,000 " |
| " Russian " | 130,000 " |
| All other | 830,000 " |
| Total | 6,700,000 " |

These figures include all shapes and sizes of merchant steamers. I may also add that the best foreign steamers are as a rule built in Great Britain.

[1] A practical illustration may be useful. Taking the June quarter of 1860, two-thirds of the commerce of New York was carried in American bottoms; in the same period of 1863, three-fourths was carried in foreign bottoms.

arrangements for war are commensurate with our commercial necessities, the British mercantile marine will probably disappear in a reaction of panic.[1] What will happen during these first few weeks depends primarily upon the accuracy and extent of our naval intelligence. Peace affords the only opportunity of organizing and systematizing such intelligence, and maturing our plans. That opportunity will be gone when many submarine cables are dumb, when excitement reigns on British Stock Exchanges, in two hemispheres, and merchants and shippers crowd Whitehall clamorous for naval intelligence. Are they then to be referred to the Military Intelligence Department in Pall Mall, to obtain full details as to the roads to Berlin?

6. It is also of importance that all particulars concerning the exact position, nature of bottom, and depth of water in which submarine cables are laid, should be collected and furnished to naval commanders, so that they may know where to cut or tap them, or prevent others from doing so.

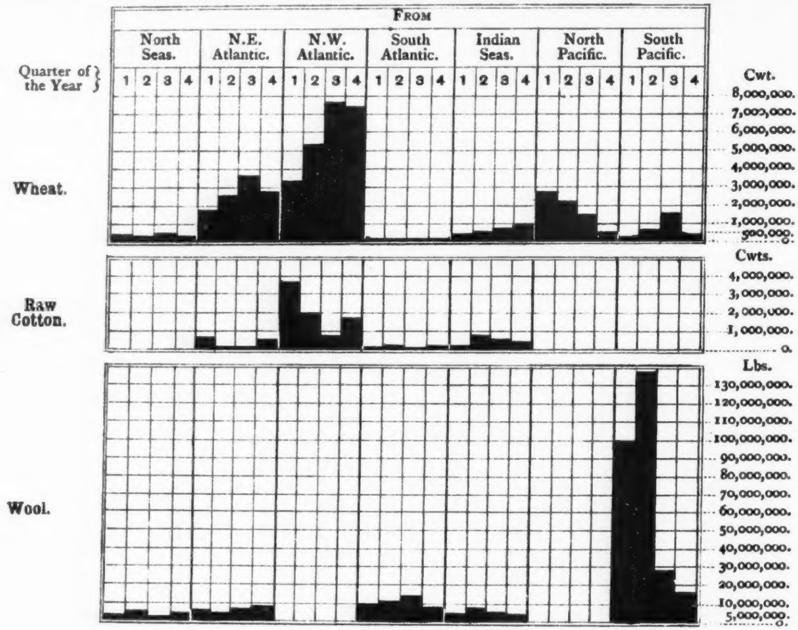
7. The necessity for collecting and rapidly disseminating information at all times as to the movements of foreign ships of war is so obvious as to require no explanation. It is to be hoped our method has been improved during the last twenty-seven years. Facts which I have come across in the course of my investigations, have astonished me in the overwhelming testimony they bear to national carelessness in this matter during the Crimean War. For example, as I have elsewhere stated, the officials at a most important naval outpost were left to learn that England was at war, from chance newspapers, and to the end of the war no official instructions were sent to them. In another quarter of the world, though we had steamers on the station, a Russian frigate rode at anchor in the middle of an English squadron, months after the Guards had been cheered through the streets of London, on their way to the East. Seven weeks after her parting company with the English squadron, she passed on the high seas under the stern of an English man-of-war. I happen to know the latitude and longitude where the curious scene occurred of an English vessel of war dipping her ensign to the frigate of a Power we had been fighting for months. Had there been any real attempt at the organization, collection, and communication of naval intelligence before and during our last war with Russia, disaster and defeat of British naval forces in the North Pacific would not now stand recorded in that same "Times" containing the telegraphic news of the Balaklava Gale, and the official despatch announcing our military survival at Inkermann. We did not then choose to have systematic naval intelligence as to the movements of enemy's ships, and the nature of fixed naval positions, and naturally we paid dearly for our neglect with the lives of Englishmen. "The wild roses and purple-"hooded bells nodding,"[2] over long rows of English graves in the

[1] In 1860, 13,638 tons of shipping were transferred from the American to the English flag. Month after month the number of tons transferred increased. In 1863, 252,579 tons were so transferred. Between 1860 and 1864 the American tonnage was reduced by some 2,000,000 tons.

[2] See "Tent Life in Siberia." Kennan.

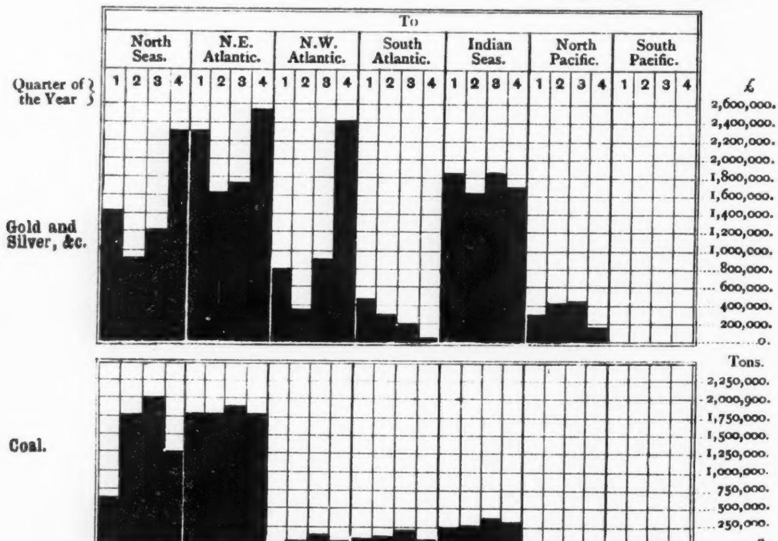
# IMPORTS.

**Diagram illustrating average variation in volume, according to period of year.**




# EXPORTS.

**Diagram illustrating average variation in volume, according to period of year.**




Harrison & Sons. Lith. St Martins Lane W.C

"green grass valleys" of Kamtschatka, mutely appeal for better naval intelligence. In 1855, we were unsuccessful off the coast of Asiatic Russia. The whole Russian squadron and garrison evacuated the position we had made great preparations to attack. It avoided one of our fleets, and was found by another, but escaped. All this was due to the absence of organized naval intelligence. Ten years later, and in the regions where all these scenes occurred, and where Russia is now wisely accumulating war cruizers, the wrecks of thirty Federal ships[1] strewed the shores of Behring's Straits, testifying to the naval intelligence possessed by the commander of the "Shenandoah," and to its total absence in Federal naval arrangements. To examine closely one of the foregoing sub-heads of naval intelligence necessary for naval efficiency, would require a whole series of lectures, and therefore, I can now only—by way of illustration—pick out one or two more prominent features of some for special notice.

As regards value, Table I (*see* Appendix) shows the value of imports and exports of the United Kingdom from and to ocean districts in one year (1879), it further distinguishes between the values passing from and to the foreign and British seaboards in those districts into which I divide the world, their geographical limits being as follows:—

*Northern Seas District.*—On the west by a line drawn from Dunkerque towards the Pole through Dover, the eastern boundary being the seaboards in the German Ocean and the Baltic Sea.

*North-East Atlantic District* is bounded on the west by 30° meridian W., on the south by the Equator, and on the east by the continuous seaboard from where the Equator strikes the West Coast of Africa to Dunkerque where it meets the limits of the Northern Seas.

*North-West Atlantic District* includes all the North Atlantic Ocean west of the 30° meridian.

*South Atlantic District* includes the seaboard of British South Africa with the Atlantic Ocean lying south of the Equator.

*Indian Seas District* takes in the water area enclosed by the continuous coast line from the north-east of British South Africa to Singapore, thence by a line, including Java, towards the South Pole and back to Delagoa Bay.

*North Pacific District.*—All the Pacific north of the Equator between the Indian Seas District and the American Continent.

*South Pacific District.*—All the Pacific south of the Equator between these limits.

The chief lesson to be learnt from Table I is the great disproportion between the value of exports and the value of imports from and to the foreign seaboards in districts where there are both foreign and British seaboards, while they nearly balance in the case of the seaboards which in these districts are British.

Where, therefore, the import or "homeward" route and the export or "outward" routes are not from physical causes geographically identical, there is a difference in the financial value to us between the lines to and the lines from foreign seaboards, while in the case of those to or from British seaboards, there is practically none. It is

[1] Whymper saw them, *vide* his "Alaska."

this sort of fact and many others which underlie it, of which naval intelligence should constantly be investigating and taking cognizance of.

Table II gives the number of steam and sailing British ships which, in one year (1879), entered and cleared the United Kingdom from and to seaboards in the several ocean districts with cargoes, while Table III gives in the same manner British ships in ballast. These figures, including as they necessarily do repeated voyages, are not the actual number of individual ships, but relatively they are strictly accurate. It is necessary to remind you, I am, in order to avoid confusion, at present confining my observations and figures to the trade and shipping of the United Kingdom only; presently I shall refer to the trade of the Empire.

Now, there are several lessons conveyed by these Tables II and III. I can, however, only refer to one or two selected for the purpose of giving continuity to these general illustrations, leaving those who choose to study them to find out the others. As regards vessels carrying cargoes, it appears from Table II that the arrival and departure of sailing ships from and to foreign ports nearly balances, while the clearance of steamers with cargoes was about one-fourth greater than the arrivals; on the other hand, in the case of British ports abroad, while the sailing ships also about balance, the steamers carrying cargo from the United Kingdom to those ports were more than double the number of those arriving.

Reference to Table III shows that out of 7,000 representing the steamers which came to or left our shores empty, only 73 entered and cleared empty from ports of our Empire. Further, out of over 4,000 empty ships which entered and cleared, but 456 came from or went to British possessions. Where, therefore, the sea lines to foreign ports do not geographically coincide with those to our possessions, the empty British ships will almost exclusively be found on the foreign sea lines. Here, again, we have a fact it should be the duty of naval intelligence to watch and digest, for sea commerce is not constant in its operation. The last columns of Table II teach a still more important lesson, showing as they do the variation in the proportion of steam to sailing British tonnage employed in the trade of the several ocean districts. In the North Seas District, the proportion is about 12 steam tons to 1 sailing; in the North-East Atlantic District, 8 to 1; in the North-West Atlantic District, 5 to 2; and in the South Atlantic, 7 to 5 only; the conditions as regards Indian Seas are reversed, there being more sailing than steam tonnage employed; in the North Pacific, there are 3 tons sailing to 1 steam; and in the South Pacific, 5 tons sail to 1 steam. These facts are important in many ways. It is impossible, however, to dwell now upon more than one or two considerations they suggest. The limits of danger to merchant ships in war as regards operations on the high seas lie between the port of departure and arrival, and as steamers traverse this area of danger at a greater speed than sailers, they are exposed to danger, in proportion to their speed, for a less time. If over a threatened sea-line a steamer can pass in six weeks while the sailer on

the same line takes three months, the risk to the sailer is double that of the steamer. Again, the steamer can, in proportion to her power, vary her route, while the sailing ship is forced, by atmospheric and other influences, into certain beaten tracks. The steamer can avoid a menaced area, the sailer cannot. I am only dealing with strategical matters, and therefore do not allude to the obvious tactical helplessness of a sailing merchant ship when in sight of an enemy's steam cruizer, while the position of a merchant steamer in the same situation may not be one of danger if her speed be greater than that of her vulture opponent. Under these circumstances, to push enquiry no further, it may be said that the danger to which our sea commerce is exposed in any ocean district is proportionable to the preponderance of steam or sail tonnage. Taking the Table (I) of value with Table (II) of shipping together, it may, by way of general illustration, be assumed that, other things equal, though the total value to the United Kingdom of the North Seas District is three times that of the South Pacific, the danger to which the United Kingdom commerce in the South Pacific would be exposed in war is five-fold as compared with the North Seas. We have here, again, matters requiring vigilant and constant observation at the hands of naval intelligence, for the proportion of steam to sailing tonnage is never the same, it is steadily increasing,[1] but not uniformly in all trade directions. Every ton of steam substituted for sail tonnage is a gain to the strength of our naval position in war, provided our naval intelligence and arrangements are sufficient to prevent its being frightened under a foreign flag by failure to protect our commerce at the commencement of hostilities.

The first line of Table IV gives, in round numbers, the total values of ocean districts to the United Kingdom already given in full in Table I. The second line gives the values of ocean districts to India and the colonies, *exclusive* of their trade with the mother country. Had these two islands been sunk beneath the sea, or otherwise disappeared from the map of the world during the year 1879, the figures on the second line of Table IV would still have represented the values of surviving British exports and imports during that year, the aggregate being nearly 200,000,000*l.* The third line adds together the figures on the first two, thus giving the Imperial values of the several ocean districts. Thus, it will be seen that the total value of British commerce to be protected in war is about 800,000,000*l.*: more than one-fourth the sea trade of the whole world, British Empire included. It has been estimated that some 70 per cent. of the sea trade of the world is carried in British ships, and that the value of

[1] The number of steam and sailing vessels (British) engaged in foreign trade in 1869, as compared with 1879, illustrates the above statement:—

| | | |
|---|---|---|
| 1869— | 810 steamers, | 6,963 sailing. |
| 1879— | 2,027 „ | 4,832 „ |
| | | 2,183 decrease. |

During the years 1877–80 the number of British steamers increased 22½ per cent., of French 25 per cent., German 17½ per cent.

British shipping is some 100,000,000*l.* I should here remind you of the consequent enormous number of British ships employed carrying goods from foreign ports to foreign ports of which we have no account, but which will equally require protection in war. To conclude remarks on the simple values of ocean districts and shipping, it is desirable to observe that while the annual value of British sea trade is some 800,000,000*l.*, and though the value of British shipping on the oceans and seas is worth some 100,000,000*l.*[1] more, we are without any organized system of naval intelligence necessary for its safety in war, and the popular national idea seems to be that were the "Inflexible's" sides only made thick enough, her guns big enough, and the Admiralty worked cheap enough, she should almost single-handed provide safety for such gigantic trade.

But the simple values of ocean districts already given does not represent the real value of British commerce which passed over them in one year. There is a process of accumulation due to the movements of commerce over the area of some ocean districts in passage to or from others. Table V shows the oceanic accumulations resulting from the movements of British commerce in 1879, from hemisphere to hemisphere only. There are other and minor accumulating processes which must here be passed by. I compute the value to British commerce of the great passes from hemisphere to hemisphere as follows:—

| | |
|---|---|
| *Viâ* Suez Canal | £82,600,000 |
| ,, Cape of Good Hope | 50,000,000 |
| ,, ,, Horn | 33,400,000 |

It will be seen from this table that while the simple value, for example, of the South Atlantic district is but 28,700,000*l.*, the volume of trade passing *viâ* the Horn and Cape raises that value to 112,200,000*l.*; and, in like manner, there is an increase of simple values, as shown by the table, in the case of the South Pacific and the Indian Seas districts. As regards the North-East Atlantic it is obvious that, as the southern and western seaboards of the United Kingdom are situated in that district, and as the United Kingdom trade with all districts, except the North Seas, is 449,500,000*l.*, these figures represent the accumulated value of the North-East Atlantic to the mother country only; but as the rest of the Empire has a trade in this North-East Atlantic district of 26,900,000*l.*, and also a North Sea trade passing over it of 1,400,000*l.*, the Imperial accumulated value of this North-East Atlantic district is 477,000,000*l.* The actual value of the waters of the United Kingdom is, of course, represented by its total trade with all districts, viz., 600,000,000*l.* odd. I cannot say more on the variations of values as regards place, but must pass on to illustrate variations as regards time. Accumulations are not simultaneous, and it would be the function of naval intelligence always to know not only where the major and minor accumulations are taking place, but also when and how. As the movement of the protecting force must be ruled by the movements of commerce, to be without such intelligence kept up to date is, to

[1] The value of British goods, &c., on the sea in each year exceeds our total National Debt!

my mind, to court terrible national disasters on the outbreak of war. At Lloyd's it is daily known where British ships are[1] in certain districts, and probably on the declaration of war that association would telegraph telling merchant ships where our war vessels were when last heard of. But these war vessels will change positions; perhaps they may be looking for enemy's cruizers whilst our merchant ships are looking for them, as did Federal war vessels which never caught the "Alabama" until she was driven into Cherbourg by need of repairs. The system at Lloyd's is perfectly adapted to Lloyd's business—insurance for the protection of individuals directly concerned against the risks of the sea: it could daily furnish much valuable data necessary to naval intelligence required for the protection in war of our greatest national interests.

The diagram headed "Imports" illustrates in a simple manner the increase and diminution of volume varying with the seasons of the year. It is not necessary to point out the original causes producing the results here exhibited. Every one knows that the harvests of the world are not simultaneous, and that when in one hemisphere they are reaping in the other they are sowing. But there is another influence which determines the period of the year at which the crop reaches us, the sea distance it has to cover *before* it reaches us. For example, the wheat which comes to us from the North Pacific States of America is grown within a comparatively short distance from that which finds its way *viâ* the North-West Atlantic, from the neighbouring districts of the United States; but from the date of "export" from those seaboards respectively until the date of its arrival here there is a difference of three and a half months. A grain vessel leaving Portland, Oregon, for the United Kingdom will, as regards time, be in war exposed to risk of capture for four and a half months, while the grain vessel simply crossing the North Atlantic will only be so exposed for one. North Pacific wheat will be accumulating in the South Pacific in the last quarter of the year, and more Australian wheat exposed to capture "off the Horn" when the trees are budding in Hyde Park than at any other time. The dates and extent of maximum accumulations of our wheat, raw cotton, and wool at various points in the ocean can be broadly arrived at from this diagram. I shall merely draw attention, however, to three general facts. From a successful attack on our commerce in the North-West Atlantic in the autumn we should suffer most as regards food. If that attack was delivered

[1] Through the kindness of the Secretary of Lloyd's, I am informed of the following facts showing progress of our mercantile marine and Lloyd's system:—

*Number of Reports of Sailing Arrivals, &c., Lloyd's Lists,* 1860 *and* 1880.

| | Sailings. | Arrivals. | Speakings. |
|---|---|---|---|
| 1860............. | 33,899 | 158,921 | 11,507 |
| 1880............. | 288,919 | 373,822 | 24,258 |

two or three months later the hands in Manchester cotton mills would suffer the heaviest blow; if, however, in the spring of the year our commerce passing over the South Atlantic was interfered with, Yorkshire operatives would be the greatest victims. The export diagram shows how the flow of precious metals is to some ocean districts constant, and to others variable as the seasons change. An import diagram of gold and silver would show a different distribution, but about the same amount coming as going; the South Pacific column would not be a blank, as on an average some five millions a year comes from Australia. The coal diagram shows the tremendous absorption of British coal by seaboards in the North Seas and North-East Atlantic districts, which are, with small exceptions, foreign, not British. It will be seen from this that on the outbreak of hostilities there would not be much difficulty in the supply of British coal to enemy's cruizers, it can be easily trans-shipped at neutral ports and sent in foreign bottoms where needed. On an average, 1,300 British and 1,100 foreign coal-laden ships leave our shores in each month for the several ocean districts according to their demands. Whether in war our enemy's cruizers get British coals to enable them to operate against British commerce will entirely depend on British naval intelligence. The commander of a cruizer knowing his business would be fully aware at what points out of sight of neutral seaboards he could calculate on capturing from one to perhaps fifteen British coal ships *per week;* while a British naval commander, perhaps in search of him, and with coal bunkers half empty, might be on a main route, say 100 miles outside, and not know where to find coal on the sea, because he has never had an opportunity of learning, and no naval intelligence is organized to put, in war, complete instructions on this and other matters into his hands with his sailing orders. It may be asked, how is the hostile cruizer's Captain to know where to go to? The answer is simple. The interest of trade necessitates the publication of complete information for its own purposes. The operation of enemy's cruizers and the instructions to their commanders will unquestionably be carefully calculated and prepared from information collected long before and up to date from voluminous papers and returns—some official and others non-official—daily published in England, that great centre of the world's trade and great national defaulter in this matter of organized naval intelligence for war.

I would here take the opportunity of expressing my obligations to Mr. Woods, the editor of "Dornbusch's Lists;" Mr. Turner, of the "Mark Lane Express;" Messrs. Gooch and Cousins, of the great wool warehouses; to the editor of "Brown's Export List," and others too numerous to mention, who have enabled me to accumulate more facts than I could possibly make use of in a single paper here. I am also greatly indebted to the Peninsular and Oriental, the Royal Mail, the Anchor and the Pacific Navigation, and other companies, for much information kindly and readily afforded. In order to give some idea of the importance of our sailing trade, and for reasons which will presently appear, I have made out Table VI, which shows roughly the average number of grain and wool laden sailing ships on passage per

week in each quarter of the year to the United Kingdom from three ocean districts. I have omitted the wool trade of the South Atlantic, because the larger proportion of Cape wools comes as part cargoes in regular steamships; also the North-East Atlantic, because the grain and wool from the Euxine and Egyptian seaboards comes also in steamers as a rule; last year, for example, the average number of grain-laden sailing ships passing Constantinople for the United Kingdom was about eight per month, while the average number of steamers so passing with parcels of grain as part cargoes was twenty-two per month. With reference to the shifting of the sources of our food supply from the east of Europe to the Western States of America, I may incidentally state that over 1,400 British ships (to say nothing of foreign) carried grain to us from the single port of New York last year. This sailing ship table is compiled from the best trade sources of information; but at best the figures can only be an approximation very far short of the actual numbers, and are only produced here for the sake of rough illustration.

I would observe that the diagrams and the table of sailing ships on passage represent the averages not for one year, but of a series; in the case of the diagrams the last six, in that of the table the last three years. Time compels me to abstain from further illustration, or from following up the complication of lessons those so rudely drawn, teach. A great variety of very important matter I am obliged to leave wholly unnoticed. With the facts and figures herein offered I put in juxtaposition an extract from the speech of a most able naval administrator of our own time. "When," said the Duke of Somerset in the House of Lords, "I was at the Admiralty, the little squabble about the "'Trent' question happened. One of the Lords asked me what would "be done in case of war. I replied, 'I can tell you one thing I shall "'do—you will have to sleep on the Admiralty Board table, for I won't "'let you away.'"[1] In full view of even the outline of facts I have produced, and with this statement staring us in the face, I would ask, should not the unfortunate Naval Lord on the table—sleepless with work and crushed with an Atlas burden of responsibility—have at least the assistance of an organized and far-reaching system of naval intelligence? As regards information concerning the naval means and preparations of foreign Powers, I have no wish to raise a discussion as to whether a separate department of the Admiralty should be created for this special purpose, because the subjects for digestion are so various and so essentially different, that most probably it would be better for each branch, such, for example, as the construction or gunnery branch, to collect information relating to its own peculiar functions, rather than endeavour to lump every description of information in one single department. It is, in short, a purely departmental question, which those acquainted with the internal working of the Admiralty are alone competent to discuss. I do, however, venture to maintain that our huge sea commerce requires a special and distinct Intelligence Department so constituted as to be in a position to ensure that the

[1] *Vide* 'Times," February 17, 1871.

Admiralty shall at all times have at its command the fullest and most complete information respecting the positions of our commerce on the sea, and the best possible intelligence relative to all those special matters to which I have referred. Further, I submit that such a department to be really efficient must absorb in itself the active, practical co-operation of the representatives of the great commercial interests to be protected on the sea in war. I may briefly outline my idea as to its constitution evolved by many years' consideration. I should wish to see established a Commercial Intelligence Council. The President to be an Admiral with a seat at the Board of Admiralty, but whose sole time should be devoted to the collection, organization, and digestion of intelligence necessary for the direct defence of sea commerce; he should have no other duties, for assuredly he would have more than enough to do. The members of the council of which this Admiral would be president, should all be representatives of the greatest shipping and chief export and import interests, and the position and emoluments of these members should be such as to secure the services of those who have the fullest confidence, and the most intimate knowledge of the interests they represent, so that a seat on this council should be deemed to be of importance to the nation and a high honour to the individual. The Admiral would then be in direct communication with the best sources of information, and his naval knowledge and experience would enable him to sift and lay information before the Board of Admiralty in a form available for practical application. There must, however, be subordinate departments in our great colonies, presided over by naval Officers of superior rank, and civilian members chosen on similar principles, for there is nearly 200,000,000*l*. of British commerce on the sea which finds neither source nor destination in the United Kingdom. These minor councils must work on the same lines as that at headquarters, and supply the Admirals on the station with all information. It may be exclaimed that this would involve expense. My reply is, most certainly; but surely a Power having 100,000,000*l*. worth of shipping and 800,000,000*l*. worth of goods on the sea in each year, and which freely spends some 6,600*l*. a-year on "Military Intelligence," cannot grudge 15,000*l*. or 20,000*l*. a-year for the purpose of collecting and organizing intelligence necessary for the safety of such wealth. The trade and shipping interest in Parliament is doubtless able to ensure the passing of a vote for the purpose so deeply concerning itself.

But even assuming that these centres of naval intelligence are established, one great question still presents itself for consideration. How is it to be communicated in war to naval commanders stationed perhaps in mid-ocean and merchant ships on passage? It is hardly within the bounds of possibility that we can spare swift vessels to run about the world with no other object but communicating orders and intelligence to fleets, squadrons, and ships. I cannot close without some brief remarks upon this most important branch of my subject. In the first place, it appears to me that in the direct protection of commerce, two main conditions have to be fulfilled: 1st, the protection of the main ocean routes; 2nd, the protection of the water areas

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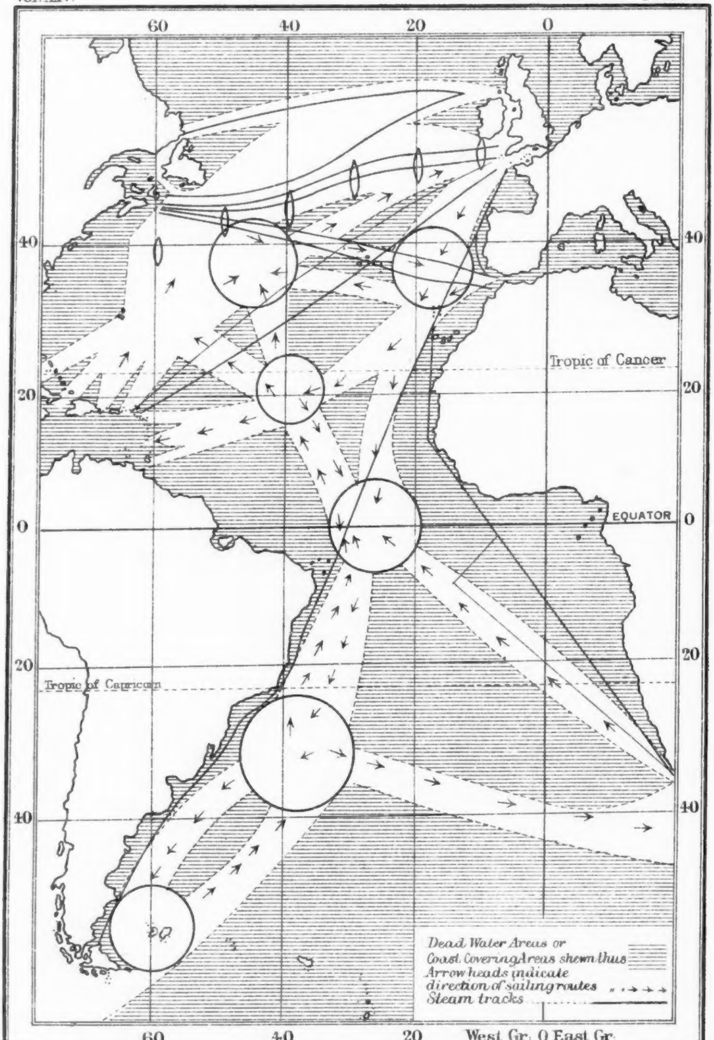
# SKETCH MAP ATLANTIC OCEAN

Plate XVIII.




Capt. J. C. R. Colomb

Stanford's Geogl. Estabt.

lying between the main ocean routes and the trading seaboards. We have, therefore, in maritime war to provide for three great naval operations, each having special circumstances peculiar to itself: 1st, the blockade of the enemy's coast; 2nd, the securing of the ocean routes of the world; 3rd, coast covering operations off neutral seaboards to provide safety for our commerce on passage between such seaboards and the ocean routes. I must confine my remarks entirely to intelligence on the ocean routes. Reference to the sketch map I have prepared of the Atlantic Ocean very roughly indicates the main routes. I take this water district of the world for example, because it is, as we have seen, the area of greatest accumulation, and, further, because it is in a strategical sense the simplest to deal with. The shaded portions indicate what may be termed the "dead water areas" where they appear in mid-sea, and "coast covering areas" where they have land for one or more boundaries. The unshaded channels represent roughly the sailing waters, the arrow-heads indicate the direction of the route, and the circles indicate the junctions of one or more of these routes, the black lines crossing the shaded parts of the Atlantic Ocean are certain steam lines. To shorten and simplify my illustrations so as to save time, I shall only allude now to the southern portion of this sketch. I must, however, remind you that the areas enclosed by these circles must be held secure; that while their strategic value in a geographical sense does not change, the pressure of commerce, so to speak, varies in some cases with the seasons of the year; that there are in this one section of the ocean six circles, and each would require a considerable squadron to provide adequate safety, and that there is, over and above all, this one great main route across the North Atlantic with its own special peculiarities and naval needs. I might remark also that the diameters of these circles are not all equal; nor is the value of commerce passing over them the same; nor will the greatest periodic accumulations of commerce within these areas take place simultaneously; nor will the distribution of the squadrons protecting the areas be uniformly the same, as each has its own peculiarities of physical circumstances. I may call attention in passing to the fact that, as Table V indicates, some hundred millions' worth of our commerce annually passes over that part of the Equator enclosed by the circle on the sketch; in extent it is some 600 miles, and therefore a 12-knot steamer would take over two days simply to go from one end to the other, a considerable squadron would therefore be required for the adequate protection of this most important position. But, as also shown on the sketch map, the great steam track to the Cape crosses the Equator a long way to the east of this circle, and as a general rule on every ocean, in proportion to the power and endurance of the steamers employed, so do their routes vary and diverge from the sailing trade, for the more independent are they of these influences which rule the direction of the sailing trade. Now also in proportion to endurance and power are steamers efficient as weapons of war, and unless in war all the great steam lines are compelled to conform as far as possible to the sailing routes, we shall waste force, leave our position weaker than it need be, and debar

naval intelligence from being passed with rapidity and certainty along our lines. It is useless to hold the fixed positions and "strategic areas" of the sea, however securely, unless the intervals between them are efficiently patrolled; it is absolutely necessary to do both, so that a cruizer will be driven to seek the waifs and strays of our commerce in "dead water areas"; where her game will not be worth the candle, or rather the coal, or have to seek her quarry off coasts where she should be dealt with by the coast covering force. Unless the Admiral in command of an ocean fleet is kept constantly informed of the probable dates of accumulations of commerce over the various positions in his district, he must more or less be working in the dark. For example, the weekly average of grain ships due to arrive here from the South Pacific during last August was thirty. It is known in the City what number of vessels and what quantity of food stuffs are on passage and from whence and when these ships are due to arrive at our ports. These South Pacific grain ships would have been due to arrive within the limits of the equatorial circle in July, and a naval commander there might have known even the names of the vessels and all particulars about them six weeks before they came within the limits of his command. More than this, if the great steam lines conform to the sailing routes in war, each steamer would not only bring intelligence from squadron to squadron on the line, but would collect by observation a great deal of information as to the commerce *en route*, and communicate it to the squadron in passing. No cruizer could appear at any point of the routes without its being thus very soon known even to Admirals hundreds of miles away and in mid-ocean. Now it appears to be assumed that the best of our merchant steamers are to be armed, not for the purpose of continuing to follow their ordinary avocations in defiance of "Alabamas," but for general service here, there, and everywhere, supplementing our regular squadrons or carrying military expeditions. I would, therefore, submit for discussion very brief observation on this matter. To avoid any misapprehension, I must first say my conviction as to arming merchant ships is this,—that the exigencies of maritime war will necessitate our arming not merely a careful selection of the best, but every ocean-going British steamer. We must prepare in peace to give them at home and abroad armaments and trained instructors, and then on the declaration of war bid them follow their avocations and let our enemies know we mean to carry on our sea trade "in spite of their teeth," under the banner, if you like, of "Defence not Defiance." I see no reason why, for example, the Peninsular and Oriental Comany, with its twenty steamers a fortnight on the oceans, could not answer for the patrol and intelligence duties on Indian and certain Australian routes without any very serious interference with the ordinary duties of their trade, provided the trained gunnery instructors, guns, fittings, and magazines be forthcoming at once, when wanted at points along the lines. Now, if, on the other hand, the best of this Company's steamers are taken off the line in war and attached to the Royal Navy for general service, the gold and silver so constant in its flow as shown on the diagram must be carried in

inferior vessels, less capable of fighting or even running away from an enemy's cruizer, you thereby increase the chance of capture, and every capture will frighten so many merchant ships under a foreign flag. To an Empire unconsolidated for purposes of common defence, maritime war may prove a severe strain; it is largely through colonial subsidies the vessels employed in the Imperial Mail Service are so efficient, so capable of adaptation as weapons of war. Will their removal off the line in the hour of colonial peril produce that confidence essential to willing co-operation? As Sir Alexander Galt pointed out the other day, the colonies take more of our manufactures than all Europe; by removing the best of the regular colonial steamers, you force a considerable proportion of some fifty millions' worth of exports to the colonies and India, into the holds of the lame ducks of steam companies' fleets, and thus deliberately increase the chances of capture.

I submit such views to the examination of those who think that for general service the Royal Navy can be largely supplemented with the best of our merchant steamers, and, therefore, conclude that the deficiency in strength of the Royal Navy can be made good in a hurry by drafts on the steam mercantile marine. I venture to think that the full gravity of the problem of protection of our commerce is not even faintly realized by the country, and that what its solution involves is not in the smallest degree understood. It is a matter with which national ignorance likes to fiddle, but which national intelligence apparently fears to face. It would be very desirable that some practical experiment in order to rouse national attention should be tried. We have had manœuvres to test our readiness for invasion, why not test our readiness to guard the people's food? Such an experiment would cost but little, and might thus be carried out. Take the "Hecla," or hire a merchant steamer, give her a roving commission, such armament as she can carry, and a plentiful supply of red or white paint. Let her put to sea and disappear. Give notice to the Admirals abroad, and allow them ample time to make their arrangements to protect commerce from this pretended hostile cruizer, which, instead of capturing and burning, might be authorized to paint on the side of any British vessel boarded at discretion, either a large C for capture, or B for burnt. Of course, if brought within range of a war ship of superior gun power, the experiment must terminate, as the cruizer's career may be presumed to have finished, but by all means let her go on marking British ships until that happens, even though C's and B's crowd our ports. This experiment would be of more value than a hundred papers such as this to determine the question whether systematic organized naval intelligence is or is not a great national necessity.

# APPENDIX.

TABLE I.—*Value of Imports and Exports to and from the United Kingdom only, from and to Seaboards of the World, grouped by Ocean Districts, and for one Year only* (1879), *also distinguishing Foreign from British Seaboard Commerce in these Districts.*

| Designation of Districts. | From and to Foreign Countries in District. | | From and to British Possessions in District. | | Total value Imports and Exports grouped in Ocean Districts. |
|---|---|---|---|---|---|
| | Value of Imports. | Value of Exports. | Value of Imports. | Value of Exports. | |
| | £ | £ | £ | £ | £ |
| Northern Seas District........ | 78,420,941 | 72,082,722 | Nil.[1] | Nil.[1] | 150,503,663 |
| N.E. Atlantic ,, ....... | 78,277,323 | 55,215,551 | 801,010 | 2,540,074 | 136,833,958 |
| N.W. Atlantic ,, ........ | 93,521,458 | 31,544,755 | 17,718,615 | 9,140,023 | 151,924,851 |
| South Atlantic ,, ........ | 6,041,890 | 9,229,204 | 4,682,409 | 6,417,921 | 26,371,424 |
| Indian Seas ,, ........ | 2,040,116 | 2,449,796 | 21,681,286 | 26,429,791 | 52,600,989 |
| North Pacific ,, ........ | 17,646,906 | 9,266,247 | 1,357,085 | 3,208,227 | 31,478,465 |
| South Pacific ,, ........ | 8,100,603 | 2,486,116 | 21,964,440 | 17,959,705 | 50,510,864 |
| | 284,049,237 | 182,274,391 | 68,204,845 | 65,695,741 | 600,224,214 |

[1] It is to be observed that Heligoland and the Channel Islands are excluded from these Tables, being considered as parts of the United Kingdom.

TABLE II.—*Number of British Vessels Entered to and Cleared from United Kingdom (including repeated Voyages) with* CARGOES *from and to Seaboards of the World, grouped by Ocean Districts, and in one Year only* (1879), *distinguishing Foreign from British Seaboard Commerce in those Districts, and also Steamers from Sailers; and showing Aggregate Total Tonnage of all.*

| Ocean Districts. | From and to District Foreign Ports. | | | | From and to District British Ports. | | | | Total entered and cleared to all Ports. | | Tonnage entered and cleared to all Ports. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Entered. | | Cleared. | | Entered. | | Cleared. | | | | | |
| | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. |
| Northern Seas District | 6,547 | 2,025 | 8,262 | 2,193 | [1].. | [1].. | [1].. | [1].. | 14,809 | 4,218 | 7,275,364 | 659,931 |
| N.E. Atlantic ” | 8,342 | 2,903 | 10,476 | 4,266 | 35 | 29 | 538 | 59 | 19,391 | 7,257 | 8,529,765 | 1,147,509 |
| N.W. Atlantic ” | 1,455 | 1,628 | 1,174 | 648 | 270 | 1,639 | 330 | 1,013 | 3,229 | 4,928 | 5,562,524 | 2,991,519 |
| South Atlantic ” | 162 | 231 | 220 | 586 | 73 | 67 | 91 | 286 | 546 | 1,170 | 712,620 | 503,785 |
| Indian Seas ” | 2 | 52 | 16 | 72 | 235 | 486 | 488 | 648 | 741 | 1,258 | 1,090,282 | 1,394,647 |
| N. Pacific ” | 84 | 210 | 3 | 78 | 1 | 14 | .. | 22 | 88 | 324 | 134,162 | 315,745 |
| S. Pacific ” | 25 | 259 | 24 | 254 | 24 | 300 | 38 | 458 | 111 | 1,271 | 234,557 | 1,087,629 |
| Total .......... | 16,617 | 7,308 | 20,175 | 8,097 | 638 | 2,535 | 1,485 | 2,486 | 38,915[2] | 20,426 | 23,539,274 | 8,100,765 |

[1] It is to be observed that Heligoland and the Channel Islands are excluded from these Tables, being considered as parts of the United Kingdom.

[2] 1,444 British vessels passed through Suez Canal.

TABLE III.—*Number of British Vessels Entered to and Cleared from the United Kingdom (including repeated Voyages) in* BALLAST, *from and to Seaboards of the World, grouped by Ocean Districts, and in one Year only* (1879), *distinguishing Foreign from British Seaboard Commerce in those Districts, and also Steamers from Sailers; and showing Aggregate Total Tonnage of all.*

| Ocean Districts. | From and to District Foreign Ports. | | | | From and to District British Ports. | | | | Total entered and cleared to all Ports. | | Total Aggregate Tonnage entered and cleared to all Ports. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Entered. | | Cleared. | | Entered. | | Cleared. | | | | | |
| | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. | Steam. | Sail. |
| Northern Seas District | 2,526 | 678 | 346 | 335 | [1].. | [1].. | [1].. | [1].. | 2,872 | 1,013 | 1,711,827 | 296,232 |
| N.E. Atlantic ,, | 3,084 | 1,701 | 842 | 599 | 10 | 2 | 2 | 3 | 3,938 | 2,305 | 1,588,165 | 388,486 |
| N.W. Atlantic ,, | .. | 1 | 204 | 711 | .. | .. | 24 | 443 | 228 | 1,155 | 275,426 | 870,882 |
| South Atlantic ,, | .. | 1 | 9 | 7 | 8 | .. | 14 | 3 | 31 | 11 | 53,963 | 5,163 |
| Indian Seas ,, | .. | 1 | 1 | .. | 2 | .. | 7 | 4 | 10 | 5 | 6,055 | 4,655 |
| North Pacific ,, | .. | .. | 7 | .. | .. | .. | .. | .. | 7 | .. | 3,706 | |
| South Pacific ,, | .. | .. | 4 | .. | .. | .. | 6 | 1 | 10 | 1 | 3,864 | 714 |
| Total.......... | 5,610 | 2,382 | 1,413 | 1,652 | 20 | 2 | 53 | 454 | 7,096 | 4,490 | 3,643,006 | 1,566,132 |

[1] It is to be observed that Heligoland and the Channel Islands are excluded from these Tables, being considered as parts of the United Kingdom.

TABLE IV.—*Showing Value of Trade of United Kingdom by Ocean District; also the Value of Indian and Colonial Trade* (exclusive of that with United Kingdom); *and further the Imperial Value of the Ocean District.*

| | North Seas. | North-west Atlantic. | North Pacific. | South Pacific. | Indian Seas. | South Atlantic. | North-east Atlantic. | Totals. |
|---|---|---|---|---|---|---|---|---|
| | £ | £ | £ | £ | £ | £ | £ | £ |
| United Kingdom trade (*vide* Table I) .... | 150,500,000 | 151,900,000 | 31,400,000 | 50,500,000 | 52,600,000 | 26,300,000 | 136,800,000 | 600,000,000 |
| Indian and Colonial (exclusive of that with United Kingdom) ........... | 1,400,000 | 22,200,000 | 22,400,000 | 38,400,000 | 77,100,000 | 2,400,000 | 26,900,000 | 190,000,000 |
| IMPERIAL VALUE .... | 151,900,000 | 174,100,000 | 53,800,000 | 88,900,000 | 129,700,000 | 28,700,000 | 163,700,000 | 790,000,000 |

TABLE V.—*Showing Oceanic Accumulations caused by Movements of Commerce between the Hemispheres during Year* 1879.

| | South Pacific. | Indian Seas. | South Atlantic. | North-east Atlantic. |
|---|---|---|---|---|
| | £ | £ | £ | £ |
| Imperial value (*vide* Table IV) .......... | 88,900,000 | 129,700,000 | 28,700,000 | 163,700,000 |
| From and to North Pacific in transit, *viâ* Horn.......... | 5,000,000 | | | |
| " " " " Cape and Canal .......... | .. | 26,400,000 | | |
| " South Pacific " " " .......... | .. | 23,500,000 | | |
| " North and South Pacific in transit, *viâ* Horn.......... | .. | .. | 33,500,000 | |
| " North and South Pacific and Indian Seas in transit, *viâ* Cape.... | .. | .. | 50,000,000 | |
| " " " " " Canal ... | .. | .. | .. | 82,600,000 |
| Accumulated values caused by transit between hemispheres .......... | 93,900,000 | 179,600,000 | 112,200,000 | 246,300,000 |

TABLE VI.—*Weekly average*[1] *Number of Grain and Wool Sailing Ships on Passage to United Kingdom from three Ocean Districts in each Quarter of the Year.*

| | From North east Atlantic. | | | | From North Pacific. | | | From South Pacific. | | | | Grand Total Weekly Average Number of Ships. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | With Wheat. | With Maize. | With Flour. | Total. | With Wheat. | With Flour. | Total. | With Wheat. | With Flour. | With Wool. | Total. | |
| 1st Quarter of Year | 26 | 30 | 6 | 62 | 154 | 9 | 163 | 66 | .. | 138 | 204 | 429 |
| 2nd " " | 42 | 42 | 8 | 92 | 91 | 12 | 103 | 149 | 3 | 156 | 308 | 503 |
| 3rd " " | 71 | 78 | 5 | 154 | 41 | 7 | 48 | 123 | 4 | 58 | 185 | 387 |
| 4th " " | 66 | 66 | 4 | 136 | 81 | 6 | 87 | 85 | 4 | 78 | 167 | 380 |

[1] For the three years 1878-79-80.

Admiral Sir Spencer Robinson, K.C.B.: As the time at our disposal is limited, and many gentlemen will probably desire to take part in the discussion, I will endeavour to limit the few observations which I wish to make on this subject to the ten minutes allowed us. I think that everybody in this hall will agree with me that amongst the various sources of enjoyment, of information, and of knowledge that are put before us in the shape of lectures or discussions, which those who attend here have the benefit of listening to, and those who cannot attend have the opportunity of reading in the very valuable Journal of this Institution, never does one go away more gratified, more informed, or more instructed than when the lecture happens to be by one of the brothers Colomb, who occupy or have occupied deservedly important positions in Her Majesty's Service. Passing by this subject, I would only remark that the lecture we have heard to-day seems to me to exceed in importance and in interest any that we have listened to from those speakers, or, I may say, from any speaker in this theatre. At any rate, if it is not of superior importance it is of equal importance to any subject that has engaged our attention, and we must all feel that it has been treated with an amount of ability and research that does the lecturer the greatest possible credit. I myself feel that the burden of naval administration, in so far as relates to the defence of the country, has shifted its incidence by what has passed within three or four years, and that burden—a heavy one indeed—must compel those upon whose shoulders it rests to consider what has been somewhat overlooked, and what, perhaps, was not so serious a danger in former years as it is now. I allude to those striking facts and details that Captain Colomb, having collected with so much industry, has put before us, and that have become gradually known through writers and speakers on all matters connected with the foreign policy of this country, namely, that our food supply, our daily bread, our commerce, and our wealth depend upon keeping the highway of the ocean open, free, and, in a certain measure, under our command. Of late years the importance of this subject has practically become greater and greater. The immense array of figures that we have had recapitulated this day shows us that fact more distinctly than ever. Keeping these highways of commerce, which the lecturer has so well illustrated on the charts hanging on these walls, open and free, cannot be done without a department of naval intelligence very different indeed from any that this country has been in the habit of relying upon. The lecturer has pointed out the absolute necessity of that naval intelligence, and how it can be obtained. I am not going to criticize, I am not going to speak one word of hostility against the management of naval administration, either in the past or in the present. This I know well, that many of the subjects to which the lecturer has adverted have been under consideration for some time past. Whether the full importance of all these points is, amidst the multiplicity of business, as thoroughly recognized at present as it ought to have been in the past, it is not for me to say; but this I know, that the subject of defending the trade of Great Britain, the subject of securing her food supplies so as to ensure that they may reach this country in safety, has occupied the attention of those departments of the Admiralty most responsible for our naval construction, and for providing ships of war for the defence of our country and the safe passage of our commerce over the ocean; so that what has been said and written on this subject has not been in vain. Although I am not at liberty to state the source from whence I have derived my information, still I can say that of late years ever-increasing attention has been given to the ideas so well put before us by Captain Colomb that these highways must be covered by fleets of fast steamers, and that many fast steamers in the mercantile navy are registered, and are prepared in some measure to carry the trade and to protect the trade which we must all acknowledge is of vital and absolute importance to our national existence. Whether in past years there has been some neglect of this subject or not I do not now care to say; there is no doubt that at times there has been, to say the least, an optimist spirit pervading those declarations and those speeches that we used to hear in the House of Commons. Our naval power has been sometimes considerably overrated and exaggerated, and in no respect has the over-estimate of our power taken a more dangerous turn than in overlooking the necessity of keeping our food supply, and the highway on which it must pass, open and unmolested. Let us drop a charitable veil over the past, and

for the future, as "Hope springs eternal in the human breast,"—well! let us hope!

Captain HULL, R.N.: Admiral Sir Spencer Robinson has said all that I can say with regard to the merits of Captain Colomb's paper, and has expressed, I am sure, the sense of everyone in this meeting as to the thankfulness that we feel towards its author. I will, therefore, at once proceed to make a few remarks on the important subject before us. Captain Colomb opens thus: "It is a grave question "whether so wide a problem can be adequately treated in one short hour, and "whether a matter of the most serious national concern can be publicly discussed "without more danger of directing foreign attention to our deficiencies and difficul-"ties than hope of remedy and removal by ourselves." I think we must risk that danger. There must be a certain opening-up of what might be called the confidential system. The confidential system may be useful to England, but it may also be useful to her enemies; it may prevent naval intelligence being distributed among her defenders. In the process of that distribution it is possible that some part of this knowledge may get into the hands of the enemy, still the same information not being in the possession of our Captains, Lieutenants, and master mariners may bring serious misfortune to this country; therefore, I would propose that there should be more of what I will call free trade in naval knowledge. I would also point out that in all human enterprises there must be risk. To win anything you must risk something. Captain Colomb has called our attention to the positions where our future naval battles may be fought, and to what may be termed the strategy of the ocean, and there is very little doubt but that he has touched upon a great truth. The future battles at sea will not bear names like Trafalgar, or the Nile, or Copenhagen, but will be known by certain latitudes and longitudes of strategic centres, may be the battle of latitude 23° N., longitude 40° W. They may be called the battle of the Equator, or the battle of Cancer, or the battle of Capricorn. Another thing that Captain Colomb called attention to is the fact of the importance to England of naval battles over land battles, and one of our greatest historians writes this notable fact to England: "At Waterloo she fought for victory; "at Trafalgar for existence." What was the case then will be the case now and in the future. He also spoke of the enormous amount of British interests afloat. I think everybody will allow that there is not a vessel, I do not care under what flag she may be sailing, of 100 tons floating on the ocean, but there are British interests on board. I have here a chart which has been drawn up without any reference to Captain Colomb. This chart I compiled when at the Admiralty for the purpose of showing the sea routes and distances between the principal ports of the world. It was made not from theory, but mainly from the actual experience of the tracks followed by ships, the wind and current charts (drawn also only from trustworthy logs) only being consulted in the more unfrequented parts of the ocean. You will see on that chart that the tracks all converge towards certain points, and in the Atlantic Ocean these are the points that Captain Colomb has represented on the map that he has drawn for you. The strategic centres that he has found by theory are drawn over the positions towards which the tracks upon my chart converge. Thus we see theory and practice wedded! If you turn to the Indian Ocean upon my chart you will observe a circle drawn round a group called the Chogos Archipelago. Those islands possess a splendid harbour in the island of Diego Garcia, and only require to be resurveyed in a manner suitable for steam navigation (it is nearly half a century ago that they were first examined by Captain Moresby) to make them of the greatest importance in defence of our commerce in the East. I will not detain you any longer, but in conclusion again call your attention to the close agreement of the position of Captain Colomb's strategic centres with those of the circles drawn over points on my chart, towards which the tracks practically followed by ships are found to converge.

Admiral Lord DUNSANY: I feel that in the case of a lecture of such immense importance in every way and of such merit as the one we have just heard, one cannot render better service to the gallant lecturer than by attempting to criticize and pick holes in it. Unfortunately, my ingenuity has been baffled; I cannot pick any holes; but there are some points which are so important, not for their demerits but for their merits, that I should like to say a word or two upon them. I had thought I had a

hole to pick. I imagined that Captain Colomb thought that in future we might rely upon blockading our enemy as we did in the past. I do not think that is a legitimate conclusion. Of course it is our business to bottle our enemy up if they will let us, but I do not believe in these days of steam warfare it will be at all possible to confine an enemy to his harbour, at least, supposing the enemy is anything like our equal in force. I presume, therefore, the lecturer only meant to say we should try to do it. It is a new idea, and a very important one, that railways must afford facilities for moving fleets of efficient torpedo-boats. Those boats, no doubt, can be carried by rail, and the transport of a large number of torpedo-boats from the Mediterranean to the Atlantic coast would be one of the means which would render it absolutely impossible to carry on an efficient blockade. Here, by-the-bye, I have picked a little hole. The gallant lecturer talks about the hydrographic basin of the Amur, which he puts at 583,000 square miles. I rubbed my spectacles for some time when I looked at that, and I said to myself, surely one, or two, or three noughts must have slipped in accidentally. 583,000 square miles! I did not extract the square root to see what the sides of such an enormous basin would be, but the most intelligible way of putting it is this. If you suppose the breadth of the river to be on an average one mile, you require a river 583,000 miles long, and this little planet of ours won't hold such a river as that. You might perhaps get it in Saturn or Jupiter. The gallant lecturer speaks of the necessity of giving encouragement to naval Officers to obtain the authoritative information which will be necessary in war, and he complains very justly that we have not got such information at present. I am afraid, in point of fact, we have not exactly what we call a professional Admiralty. We have what I should say is a House of Commons' Admiralty, and budgetary considerations rather take precedence of all others. The lecturer naturally called your attention to the discovery lately made that the Germans, French, and Russians have better naval guns than ours. I am afraid it is our habit to indulge in optimism, in which we take a comfortable sleep, out of which some day we may wake to find ourselves in the most uncomfortable position. The gallant lecturer speaks about our food supply, and that the supply from the United States might be superseded in the future by a supply from Canada. I assume that he means supposing we are on perfectly good terms with the United States; because we could not reckon upon Canada supplying us in a war with the United States. I am afraid it would pass into the hands of the bigger Power. I mention these things to give the gallant lecturer an opportunity of answering, which we know is what he would naturally desire. A most important point which has been touched upon is that in the event of war our trade would pass into the hands of neutrals. I believe that is a commercial certainty; but many of this audience who may have been present when Sir William Harcourt lectured here will perhaps remember that he asserted that it was impossible that this country should be invaded, because no Power had steam ships or merchant ships enough to transport an army to our shores. Why, in point of fact, our own ships would pass very soon into the hands of another Power by the "underground railway." I am sure it is a wonder that, as the gallant lecturer was able to get so much into the time, he did not get much more, but I hope on some future occasion we may hear him tell of the means we should have of securing our most important traffic, that is, as it appears by these tables, the Suez traffic. It was remarked lately by some writer that the whole of our Suez traffic might be said to pass through a narrow defile which, in the event of a war with France, would have our enemy on each side. Passing events rather suggest that the narrow defile will be made a little narrower; at all events that shows the importance of the topic, and I trust the gallant lecturer will, on some future occasion, turn his attention to that point. I think I may mention a circumstance which seems to have a little public interest in connection with the gallant lecturer. An application was made to me by a very useful publisher to write a naval article. I trust that my modesty led me to think that I was not the person to do it, but, with the permission of the gallant lecturer, I am writing a letter to suggest that he should undertake it, and I trust he will do so.

Captain PALLISER, late 7th Hussars: I should like to say a few words on this very important subject. We must all agree that great credit is due to my friend for the very instructive lecture that he has given us. I am thoroughly convinced that without

individual exertion this great object of the protection of our ocean trade will hardly be carried out, at least not for the next ten or twelve years; but if he continues his exertions I have no doubt that a great deal will be done in that direction. Much attention should be given to the advantage of inducing the great Colonies to add to the fleet some swift, well-armed corvettes, so that all may see the Colonial flag flying in conjunction with the British flag in the Mediterranean, the Pacific, and all over the world. I may mention that when I was in Canada, three years since, I consulted General Sir E. Selby Smyth and Colonel Strange, Inspector of Artillery, with reference to the armament of Canada, and also as to the chances of starting a Canadian corvette. They told me that the great difficulty was money, which was wanted for railways and canals, which the Canadians thought more required for the present than corvettes or cannon. Colonel Strange and I subsequently proposed to the authorities in Canada to start manufacturing their own guns, "Because," we said, "if you can create a manufacture in Canada, you will have the manufacturer "interested; you will have his friends interested in Parliament; you will have the "coal interest and the iron interest, and when Parliament meets they all get "together, and it will probably result in the commencement of an armament." They agreed with us, and we resolved that the first thing was to see whether they could make a gun. We therefore went to a manufacturer and proposed to him to make a gun. At first he appeared very much surprised at the suggestion, and said he did not know how to make it, but I said Colonel Strange would show him. He said he could not get on without money, so I gave him some. The result was that he made, under Colonel Strange's inspection and advice, a 64-pounder rifled gun. It was tested with three times the usual charge put into the gun, and was passed by the authorities; and, to make a long story short, the Canadian Government, who place the fullest confidence in the great ability and energy of Colonel Strange, have now ordered twelve guns to be made in Canada. I may mention this subject, because of course there is no pecuniary interest in the matter whatsoever. Colonel Strange and I have the same object at heart as our friend, Captain Colomb. He is working individually in one way, and we are working in another. I am informed as soon as the guns are completed, a corvette may be eventually seen in Canadian waters, because two of the guns are specially designed for sea purposes. The same subject has been mentioned in Australia. Their press has given no uncertain sound. Leading articles have stated that anything Canada can do they are better able to do. They are much richer than Canada; they have a greater command of money, and are perfectly capable of ordering some swift corvettes, and of letting the Australian flag be seen flying alongside the British flag in English and foreign waters, a sight which would have a most marked effect on the opinion of those who envy our magnificent and universal commerce. I hope, therefore, that in a few years we shall see this great object attained, and that by preparing English merchant steam-ships for armament, and inducing our great Colonies to join the British Fleet with some splendid swift-steaming corvettes, we shall firmly establish and maintain, against all comers, our commerce in the oceans and seas of the world.

Admiral Selwyn: My Lord, I rise to add whatever tribute I can to the admiration which has been expressed of Captain Colomb's lecture. It has been a lecture adorned by a masterly mind, and painted in masterly colours, and its value is such that in all probability for many years to come it will form the subject of remark by those who take an interest in the statistics of the national wealth. The few points which I have to advert to other than those of admiration I am quite sure Captain Colomb will take, not as seeking blots, but as trying to show him that some of the colours in which he has painted are, it may be, a little evanescent, and therefore require further consideration. There is one point to which, I think, universal attention ought to be given, and that is the enormous increase in the value of the commerce passing westward. We used to consider that our eastern commerce was the great source of wealth, and no doubt for centuries it furnished the wealth of those nations that successively enjoyed it. From the time when the Venetians opened up that commerce by means of their ships in connection with the eastern caravans, to the time when we ourselves took it up, we have become accustomed to think that it was the most valuable commerce of the world. Various moves have been made with the object of getting that commerce out of our hands. The masterly move of

M. de Lesseps was made, and was defeated by a still more masterly move on the part of one whom all Englishmen now deplore.[1] Another move is now made, and although it is made by friendly Powers, we must take care that it does not seriously interfere with our own interests. We must have an enormous food traffic, and to us, in whatever bottoms, must come a large proportion of the food traffic developed in the United States, and Captain Colomb's figures distinctly show what an enormous proportion that now bears to the total. I do not think that if the whole commerce of England were interrupted as far as regards the English flag, it would cause anything more than a very small rise in price of the food so transported. It would come inevitably in neutral bottoms. The question we should have to consider would be how to secure the trade and the flag, and whether a flag which is at war can by any possibility be made as secure as one which is not. That is the great question to be considered. A great deal has been done to impede such a result, which formerly could have been obtained. Since Lord Clarendon's celebrated Declaration of Paris we are no longer in the same position as formerly. We shall have to recur to that position again if we contemplate such an operation as Captain Colomb has foreshadowed, that of throwing down the gage and saying, "We will continue to be the "carriers of the world, not so much because we fear being short of food, as because "we are resolved not to lose the wealth which is the meed of the honest carrier of "the world's commerce, and which alone enables us to pay for that food." The thing would come round to exactly what Captain Colomb has stated. You would lose the wealth which is due to your carrying trade; you would lose the purchasing power and your millions, not in one centre alone, not in Bradford, not in Manchester, not in the iron districts, but the whole nation would suffer. We could no longer support in this country the crowded millions who are here, and England, as a great Power, must sink out of existence if she is not prepared to assert her position among the nations. There must be no such concession made as that the neutrals shall immediately rush at our commerce. We must let it be known beforehand that we intend to keep it, and in order to ensure that that shall be so, the most valuable precaution no doubt will be perfect intelligence on this and indeed on every subject, knowing exactly what everybody is doing, and why he is doing it, in all parts of the world. Understanding that, we shall be able to oppose intelligent force to barbaric brutality, and we shall beat it no doubt, but not unless we are prepared, not unless some organization takes place, not unless the nation comprehends that its dearest interests are involved, and that no vote of a majority, even of the House of Commons, should ever be great enough to be considered irrevocable in face of the fact that the nation must lose the whole of its position if they do not retain this fundamental part of it. As soon as it is thoroughly understood by every shipowner and by every merchant throughout the country that not alone a class interest is involved in this question, but that they will all go down together and in time sink out of existence as Venice sank out of active existence when she lost her trade; as Portugal, as Spain, and as Holland have sunk; as soon as they learn and take to heart that lesson, they will cease to listen to those who teach them the penny wise and pound foolish maxims of the day, who are guided always by a consideration of political success for the moment, forgetting that it is he who saves his country from decadence, who sees a long way ahead what are its dangers, and how they are to be confronted, who is the man who deserves a high place in a nation's history, and not he who, simply to suit some temporary cry of expediency, refuses to assert the principles which alone can save the nation. If the journals of the country only knew the facts foreshadowed in this lecture, I am sure they would turn on the tide of power which they possess to carry Captain Colomb's ideas forward to a realized success, and we should not have to lament that though our Journal contains from month to month, and from year to year, most valuable information, it is utterly neglected by those who ought to know better, but who have rarely the time or the inclination to acquire the facts for themselves.

Lieut.-Col. EDWARD R. DRURY (Queensland): The name of Captain Colomb is very familiar to us in Australia, and he is appreciated there for the great zeal with which he had advocated views which we all share, and which we all heartily approve of, that is to say, that he is a thorough Imperialist, and in his writings he has constantly pointed out the necessity of providing a better defence for the great commerce

[1] The Earl of Beaconsfield.

which is carried on between England and her Colonies. In Australia, as perhaps this distinguished audience knows, we are very democratic, but as regards the policy of the Empire I must say we are thoroughly Conservative. I have noticed that Captain Colomb has avoided certain questions which are under consideration by the Royal Commission on the defence of British possessions, and therefore I need not attempt to touch on those points. But I would venture to point out that this great question of the supply of food, which is of such vital importance to these islands, might be solved if you could manage to do with less of the doctrine of *laissez faire*, and direct the stream of emigration to your own Colonies, and when I say to your own Colonies, I naturally allude to the Australian Colonies, which contain such a vast territory that can be utilized both for the production of grain and of meat. You are depending now evidently on lines of communication which are greatly open to attack, and in these days when nations are armed to the teeth there is no knowing what may happen. I venture to suggest that you have in Australia a country which can supply what you require, and that you would have fewer lines of communication to guard if you drew your main food supply from it. I am very glad to bear testimony to the respect which Captain Colomb's writings have won for him in Australia.

Mr. Donald Currie, C.M.G., M.P.: It is always a gratification to hear Captain Colomb; he is so practical; he has a largeness of view and wide scope of observation in what he has to think of and says; and he is patriotic. Of all his papers I do not know that I have heard a more clear or far-reaching one than that which he has read to-day. The great want, I think, is intelligence on the part of the public as well as of an Intelligence Department. There is a want of political intelligence, and a very large want of intelligent acquaintance with our own national position. I do not think we are at all in a safe condition, and I quite agree with Captain Colomb that the nation does not know the risks of our position. If anyone will read what a Staff Officer of the Austrian Army wrote the other day in one of the magazines, taking as his text some observations made by the eminent statesman referred to by Admiral Selwyn, you will see that he demonstrates very clearly that for the protection of the extensive commerce of this country in the event of war, England is not so well prepared as we all believe her to be. This writer shows that if we were engaged in hostilities with even one naval Power of eminence we should have the greatest possible difficulty in maintaining our communications with our distant possessions in protecting our trade. We have no graving-docks on the high routes of commerce; we have no graving-dock between this country and Australia, or between England and India. This is an illustration of the unreadiness of this country; there is a want of intelligent apprehension of our necessities in time of war; and all this has to be brought to the knowledge of the House of Commons and of the country. We have had our own wars within the last few years, and as far as I have observed things, we only waken to thoughtful observation as to our great need when a disaster occurs. The battle of Isandlana forced us suddenly to supply a telegraph to South Africa, which for many years we had been asking for; and you may remember that in this Institution, in 1878, it was urged upon the Government to have a telegraph to the Cape in view of the prospect of war. So on the Atlantic: up to this day we have no telegraph to Bermuda to connect Halifax and the West Indies with that naval station. The great want, as far as I can see, is an intelligent national conception of what our policy should be in advance on given subjects, and an intelligent plan and arrangement of what our action and execution should be in the moments of emergency and war. Can I give a better illustration than the Transvaal? We annexed that country, and for three years we have been well aware that we held it upon slender ties. Well, the want of political intelligence, and practical arrangements, and preparations were apparent; when danger appeared where were the means for providing against the emergency? For example, it was unknown to people in England that good mounted riflemen would be required in a war in the Transvaal. I should like to know where we should be in the event of a war when occurrences take place such as Captain Colomb refers to, if we are not ready. When we were fighting Cetewayo we had three men-of-war upon the African station, and two of them got disabled, but there was no dock in which to put them. Suppose that had occurred while we were at war with a great naval

Power like France. No steps have yet been taken to provide a graving-dock at Simon's Bay. The truth is not so much as one speaker has it, that the House of Commons is to blame; the fact is, we want more intelligence in the country and in the Departments, and this with less of party spirit.

Mr. FREDERICK YOUNG, Honorary Secretary, Royal Colonial Institute: I should like to make one observation. It is, that I draw, as everybody present must draw, from the admirable and instructive lecture we have listened to this afternoon, the practical conclusion, that it is of the most absolute necessity that a Naval Intelligence Department should as soon as possible be established. One most curious and remarkable thing is this:—In the course of the paper Captain Colomb alludes to the fact of our having a Military Intelligence Department at a cost of 6,600*l.* a-year; and he suggests that it would not be very much for the country to spend 15,000*l.* to 20,000*l.* in having a Naval Intelligence Department also. When I see from the gigantic array of figures which are before me at this moment, the enormous amount and value of British commerce on the seas requiring to be protected in case of war, it does seem a most astonishing thing that we do not possess in this country an efficient Naval Intelligence Department at a cost of even some 15,000*l.* or 20,000*l.* per annum, which, being established, would fulfil all the requirements which Captain Colomb has laid before us in his very interesting and important paper.

Mr. AGNEW POPE: I have only a very few words to say in support of Captain Colomb's observations on the shortcomings of the Consular Reports. The Consular Reports that I have had to examine, presented in January and February of this year to both Houses of Parliament, only give the matters connected with the respective countries up to the year 1879. At the same time I find that the American Consular Reports for January and February, 1881, have been sent to Washington, published in March, and are already in this country. Having no Consuls in the Colonies, it is very necessary that the department which Captain Colomb has suggested should have the means of giving the public some information from the Colonies such as the American Consuls give their nation. For instance, there is a report from Melbourne of January 24th, published at Washington, and has come over to this country, containing all the awards given to the American manufacturers. Now, considering that in the years 1878 to 1880 our trade has fallen off with the Continent 14 per cent., and has increased with Australia 54 per cent., and with British India 29 per cent., it is very important that we should have some further means than we have now of obtaining direct information from the Colonies. Our carrying trade has increased with all countries, and the American Consuls I find deplore that down the east coast of South America the American flag is never seen in those waters. One Consul mentioned casually that the only mast-head he ever saw with an American flag above it was the mast-head of his own Consulate.

Captain CURTIS, R.N.: It is about a generation since the commencement of the last Russian War, and any Officers who were present during that war well remember the difficulty experienced in manning our ships. I was in the "Royal Albert" when we were five months without being fully manned. The men that we took eventually to complete were the Coast Guard men from the Baltic ships who had been promised leave when they came home from the Baltic; and I must say it was very heartrending to see the disappointment of the men. It is an old maxim, that to be prepared for war is to avert war. I find in "Whitaker's Almanack" for 1881 the Imperial exports and imports are put at 917,000,000*l.*, and I should like to know whether, as a recent member of Parliament said in the House of Commons, with our naval expenditure we pay too dearly for our Imperial insurance, for I suppose it would be correct to call the Navy and the Reserve Forces the Imperial insurance for the mercantile marine. I should like to know when our Colonies are coming of age, and are ready to help the mother country by subsidy or otherwise, and to protect in transit their own exports and imports. I must say I should like to see the emigrants follow their own flag. Taking our commerce and merchant shipping at 1,000,000,000*l.*, and our expenditure at 10,000,000*l.*, our Imperial insurance comes to 1 per cent. for our import and export trade and the insurance of the ships that carry that trade on. I think the naval expenditure should be at least 15,000,000*l.* a-year, and then we should be prepared for war, with a good and

efficient "reserve of men" and reserve of ships. This country has paid 200,000,000*l.* for guano from Peru. That sum of money might have been spent in developing our fisheries, and by developing our fisheries and by enriching our soil with English fish guano. Developing our fisheries by utilizing the offal fish now cast back into the sea—mixing it with sulphuric acid and gypsum—you will obtain an article superior to guano; it is estimated there are 50,000 fishing boats[1] in the United Kingdom. We should then have seamen to protect us. The Irish fishermen have dwindled down from 113,000 to 23,000 from 1846 to 1875, boats reduced from 20,000 to 6,000. The fact is, that we are supplying foreign countries with men instead of developing our own resources, and then we are praying the House of Commons to relieve the agriculturists. I say if man will do his part, God will do the rest. We are told to "subdue the land and replenish it:" we subdue it but we do not replenish it. Take the insurance of $1\frac{1}{2}$ per cent. as I have suggested. At Lloyd's during the war with France the insurance was 25 per cent. on vessels under convoy, and 30 per cent. on vessels not under convoy. I find from an old journal belonging to my father an account of the cruize of a privateer from 1st December, 1778, to 21st September, 1779,[2] kept by a seaman of the "St. Germain," that may perhaps teach us what to expect. She was cruizing in the Archipelago, and with a crew composed of Italians, Russians, Englishmen, and Greek pirates, she did a great deal of harm amongst the Turks, and sometimes other nations; not scrupling to murder the passengers, in fact, beheaded them and quartered them, each man cutting off three or four heads per diem; the few they spared were those that gave information. The Englishmen refused to take part in this at first, but they were called cowards, and at last got so bloodthirsty that they were the first to execute their victims. This shows what people may come to; and if you have a mixed crew on a pirate ship you will find that they won't be scrupulous about their passengers if they cannot land them, even in our days.

Mr. H. Kains Jackson: I must congratulate Captain Colomb on the opportuneness of his paper; for, at this particular moment, in proportion to the population of England the stocks of food are at the lowest possible point. In former times the farmers would grow nearly all the bread the country wanted for daily consumption, and they kept all their eggs in their several baskets; but, at the present time, the policy of confidence that we show in the foreigner is so extreme that we trust entirely on some two months' consumption for them to bring over the food in steamers which are now in reality floating granaries, and at the present moment the stock of wheat in this country is lower than it has been, in proportion to the population, for twenty-five years. It is generally lower throughout Europe than it has been for that period, because we have bought so much, and are able to buy so much in the market, that we rely entirely on the fleets of ships bringing the supplies; but it is only a matter of common prudence that we should make proper provision for the due arrival of those supplies. I have no doubt in the English Navy being able to protect our commerce, large as it may be; but still I should like to see that the English Navy has an Intelligence Branch the same as in recent wars the French found to their cost that other countries had in their armies, and which gave them a marked superiority. With proper precaution, I have no doubt the supplies we look for will come in due course, but, as a matter of fact, there are two million quarters of bread-stuff now afloat coming to this country, exposed to the wind and the weather, but which would also be exposed to the operations of any enemy that might be opposed to England. I beg to congratulate Captain Colomb on the opportuneness of his paper.

Mr. George Duncan would preface what he had to say on this subject, by stating that the ships coming into existence at the present moment in this country amount to 1,000,000 tons. There are 825,501 tons building under the survey of Lloyd's Committee, in addition to which the ships building not under Lloyd's Committee will bring the amount up to 1,000,000 tons, a total out of all proportion to what we have had in the past. In 1875 the number building was just about one-

[1] Our Deep Sea Fisheries, 1879, from "Standard."

[2] The journal was read to Lord Hood by Captain Keats of the "Niger," on board which ship the said Davidson was serving.

half what it is now. To my mind that is one element that helps us very much, because if we are to be put off the sea as carriers, we are certainly going very rapidly ahead at present, and, as sailors say, "a stern chase is a long chase." I think the lecture is a very important one. What we really need is information. I am not frightened about our being put off the sea, nor yet as to our wanting food; but there is no use hiding this fact. Mr. Bright has published the very worst that could be said, for he stated that three out of every four loaves come from abroad. It is not so much as that; it is not much more than one-half; therefore, he has made it look as bad as it can in the eyes of foreign nations, and no doubt they see our weak point. I am sure, that with the enormous fleet coming into existence, and with the very large fleet of ships that we have—strong, fast vessels—we should be able, with a little alteration and a little education, to look very sharply after an enemy's cruizers. I, therefore, do not think that we shall be immediately driven off the sea. Of course we have a great many sailing ships, and if a war broke out we should either have to part with them or keep them safely in our harbours; but still, looking at the splendid class of ships now building—large, noble, and very fast ships—requiring us at Lloyd's the other day to instruct our staff of surveyors to prepare specifications larger than we have at the present moment—I do not think we need fear. We used to have specifications up to 4,000 tons, but they will not answer the purpose. People said they wanted 5,000 to 7,000 tons, and we had no rules for building them upon. These vessels are being propelled with tremendous engines, and each line wants to have a ship faster than any other line; so that we have to look all round and see that they are made strong enough; and, in addition to that, a very large number of these ships are built to a certain extent under the surveillance of the Admiralty, that is to say, they have bulkheads and other arrangements whereby they might be fitted to assist the Royal Navy in case of war; therefore, I think we are not in such a helpless case in reference to our means of defence, if we had the means of information. I do think that is a point which should come before the authorities, and as to spending 15,000*l.*, if it is 150,000*l.* a-year it ought to be done. That information may be made very valuable to us as merchant shipowners. The American Navy did a very important work in furnishing the charts, which they did for the purpose of giving the tracks of winds and currents. Formerly it used to take a vessel five or six months to go to China, but they are now able to do it in about ninety days, by knowing in which direction the winds and currents prevail over the ocean. I have very great hopes of what may be done with the enormous amount of steamships coming into existence for the carrying trade of this country.

Captain COLOMB: At this late hour I shall make my reply as short as possible. With reference to Sir Spencer Robinson's remarks I will only say this, that he was nearly being the indirect cause of my finally declining to give this paper. A year ago I read an article from his pen, in which there was this sentence:—"Unwise "counsel and false economy have prevailed; England as a naval Power, though a "Colossus, is yet found to have feet of clay." As I said to myself, this "Nineteenth "Century" article of Sir Spencer Robinson will arouse the nation from its apathetic regard of our naval precautions. But, in spite of his facts and the great weight of authority he wields on naval affairs, the public paid but little serious and prolonged attention to his warnings. I, therefore, felt it almost absurd for me to come forward and expose naval defects when so little hope remained of producing practical results. It was very kind of Sir Spencer to come here to-day and speak with his experience and knowledge on this paper of mine. I had the pleasure of meeting Captain Hull, for the first time, some ten or twelve minutes before coming into this room, and he then produced that map now on the table, made some years ago by him; I have a map at home that is similar to it but not half so perfect, but we are in accord. It is, therefore, a satisfaction to me, and I hope it may be an encouragement to others, to find that without Captain Hull's knowledge and long experience in such matters, it is possible for people who are not experts to arrive at sound conclusions if they will only take the trouble. For sixteen years I have been trying to make as accurate a map as that, but I have not succeeded, and I now meet a gentleman here and find it. That is a proof, I think, of the necessity for the cultivation of naval science, and also of the necessity for the diffusion of knowledge

throughout all branches of the naval profession. With regard to Lord Dunsany's remarks, I can only say I may have worded the sentence badly with regard to the hydrographic basin. I can only say the words are actually transcribed from Maury, and he is responsible for that statement and I am not; but, at the same time, you must remember I did not mean for one minute to say that there is that enormous extent of water. It is the hydrographic basin, the superficial area drained by the Amur, and it was the coal and iron in this hydrographic basin which enabled Russia to build ships, to make her machinery, and to bring 2,000 troops down the Amur, through the Chinese territory, in spite of China, and finally defeat our forces at Petropolovski. I must take exception to one remark of Lord Dunsany's. I am not one of those who think that we could not reckon upon holding Canada. I do not think so at all, but it will entirely depend upon what view Englishmen, whether in Canada, or Australia, or the West Indies, or the Cape, or England itself, what view they take as to whether the defence of the Canadian frontier is simply a Canadian or an Imperial question. The defence of the frontier of Canada is purely a question of who is going to defend it. If it is expected that 4,000,000 of people in Canada can unaided and unsupported hold the frontier against 50,000,000 in the States, I say it cannot be done. Even if it is to be merely the United Kingdom, harassed and worried in other ways, that is to act alone in the support of Canada, I say it is difficult, but if it is an Imperial frontier, to be defended by real Imperial combinations, I do not believe it is difficult, and I believe our English race can hold it now and at all times. One more remark with regard to that question of the defence of Canada; what the Canadians are doing now with regard to the Pacific Railway is itself making the problem far more simple strategically. That railway will enable us to communicate with the naval base at Vancouver's Island, without which our fleet cannot keep the sea. It will tap the fertile regions and attract population and add huge material and numerical power to the principal defenders of the Canadian frontier, the Canadians themselves. It will shorten the route to Australia. The defence of the Pacific seaboard of Canada is necessary to British safety in the Pacific. The defence of the Pacific is necessary to Australia, and, therefore, the defence of the frontier not only becomes a question as to the defence of Canada, but it will become, as a matter of fact, in war essentially necessary to the safety of Australia. If the Canadian frontier goes, the coal depôt goes, and with the coal depôt the British command of the sea; what, then, is to become of the Australian trade? With regard to Captain Palliser's remarks, we all know what he and his brother have done in assisting the efforts of Canadians in their difficulties with regard to their guns, and we are pleased to hear, from Captain Palliser himself, the advantage which Canada has derived from the generosity of his brother and himself, and the help he has given with regard to the question of guns in Canada. There is a manufactory, and Colonel Strange, in his capacity as Director of Canadian Artillery, is the head of that establishment. Canada owes and the Empire owes to Colonel Strange a very great deal. He is still in Canada, but some regulation about a five-year appointment might possibly withdraw him at the time he is most needed. Should it so happen it will exemplify the operation of our apathy at home with regard to Imperial matters concerning the consolidation of British war power of defence. It is essential that the manufacturing arrangements now started should be completed. If these arrangements are to be complete, it is essential that they should be completed under the direction of Colonel Strange; but if Colonel Strange's time is out and the five years, through some oversight, be not extended, he might be brought home. The fact is, our Imperial arrangements are such that, as I see it stated in Canadian papers, Colonel Strange doing Imperial service may personally suffer because he is doing Imperial work, if he wishes to keep his pension or proper state he must throw up his appointment and come home. He can draw his pension if he comes to London and does nothing, but if he remains in Canada, present regulations, it is said, do not allow him to draw his pension because he is doing useful Imperial work. With regard to naval knowledge in the House of Commons, if you turn up the history of the last wars, you will find what a preponderance of naval intelligence represented by naval men there was in both Houses of Parliament. You have not got that now. Admiral Selwyn in his most able speech I think corroborated in a

very marked way the necessity of having a Naval Intelligence Department for the purpose of watching developments. I do not think any words of mine could add to what he so well said. The world is in a state of change, and therefore it is one of the grounds on which I advocate a Naval Intelligence Department, not only to find out what our position is now, but to exercise intelligent forethought, and by foreknowledge become forearmed. Mr. Donald Currie we know is an authority, and we should not be unmindful of how much this Institution is indebted to him, and I only hope that he will infuse a little intelligence into the House of Commons on naval affairs. Mr. Pope, who is so good an authority on matters connected with trade, has confirmed in a most distinct and satisfactory manner what I said about the Board of Trade returns. It is almost a hopeless task to get information up to date; and I may tell you more, that it is almost impossible to get accurate statements of the trade position of our Empire as a whole, and up to date. The Board of Trade returns in the United Kingdom, for example, say, the trade of the United Kingdom with India is so much, and then when you take up the Indian Board of Trade returns issued from the same office, you find the totals don't agree. It is an antiquated system, and we are entirely beaten by the American official returns in the matter. The official Board of Trade returns do not furnish the rough straightforward ready information you want at the Admiralty, in order to enable the Admiralty to protect sea commerce. I am sure every gallant Officer is very pleased to welcome an Australian Officer amongst us. Colonel Drury is one of the representative Officers of Australia and the Colonies, who have been the real source of much of my information on Imperial defence, and had it not been for the hearty way in which Officers like Colonel Drury have assisted me, I should not have been able to do the little I have done. I take this opportunity of thanking him personally, because I have been in correspondence with him, and also to return my thanks to the hosts of Colonial Officers and colonists who, I must say, I think have clearer views about our Imperial position than we have at home. Mr. Jackson, whose authority on this subject connected with grain, occupying the position he does in the City, I need say nothing about, for the few words he said are more to the point, and more to be trusted than any words of mine. I hope that the discussion he has heard will by degrees influence the City people that he is associated with, because we must seek to attract the personal interests of the trade, and the public of this country, to let them clearly understand our naval position. Mr. George Duncan, in his eminently practical remarks, distinctly confirms the view that I put forward. He believes that there is not so much difficulty in protecting our position. Now I take a very serious view of it. Is it not a serious thing for an Empire that has been pushing her forces and putting her foot down into every quarter of the world, accumulating this commerce on the sea—is it not a serious thing that nobody actually seems to know what our position would be in war? I am sorry to have taken up so much time, but let us hope that Englishmen may begin to see the true aspect of Imperial defence a little clearer than they appear to do now.

Sir SPENCER ROBINSON: I see few members of the Council present, but I wish to propose that this lecture which has given all of us so much pleasure and instruction should, if it is consonant with the rules of the Institution, be published in a separate form, and circulated wherever it can be, all over the United Kingdom, at the expense of the Institution.

The CHAIRMAN: Ladies and gentlemen: It now becomes my duty, as having had the honour of occupying the chair to-day, to perform what, although it is a perfunctory duty, is one extremely gratifying to me, and I am quite sure will be equally gratifying to you to agree to, and that is to propose that a cordial vote of thanks be returned to our friend Captain Colomb for his most able lecture. I am quite sure you will accord that with the unanimity that the lecture itself deserves, and perhaps I may be permitted, as a comparative stranger here, to congratulate this Institution upon the ability, the discretion, and the great order (which is always what impresses itself upon the mind of the Chair) observed in this discussion, and the thoroughly practical character of that discussion, coming from the best possible authorities upon such subjects, naval Officers, gentlemen engaged in trade, and Officers of the mercantile marine, and above all, I think I may congratulate you upon the recent remarks made by one of our very able colonists. I will not detain

you for more than a minute or two, but I would recall to your recollection, in support of the views so ably put forward by Captain Colomb, the remarkable circumstance, that without communication or co-operation at all, his what I may call "centres of vigilance," naval points upon which the attention of our Navy must in war be directed, correspond almost exactly with the carefully prepared diagram and map laid upon the table without his knowledge, by an Officer formerly of the Admiralty itself. That, I think, is as great a tribute of praise as Captain Colomb could possibly expect. I think the value of this lecture could hardly be over-estimated, because it must strike every man, it is consistent with common sense, taking into consideration the already gigantic and ever-increasing power of artillery, and above all, the still more subtle operations of submarine artillery, that hostile fleets will be extremely shy of going near each other, and that the chief operations of war will be directed towards crippling the commerce of the antagonist. It is my firm belief, and has been for many years, that the great operations of war will be directed against the mercantile, rather than the Royai fleets. Looking at the matter from that point of view, it is impossible to over-estimate the value of this lecture. I entirely agree that it ought to be widely circulated and read; that is a matter for the Council to decide, but attention having been called to it, I have no doubt the proposition will receive due consideration.[1] I would strongly suggest the propriety of a Committee of the House of Commons being appointed to consider this great national question, namely, the proper steps to be taken for the protection of our commerce in war. It is a vast subject, but it is one worthy of the consideration of the Legislature, and I think no time should be lost in appointing such a Committee. We then should have the advantage of calling Captain Colomb before such a Committee, and have the advantage of all that ability which he has shown, and, above all, his immense research, as shown by these maps and diagrams. I trust that they will not be lost. I also hope that the attention of the Admiralty will be seriously called to this matter. Stress has been laid by Mr. Duncan on this point, that what we want is information. There is no better means by which you can extract information than a Select Committee of the House of Commons, and I do hope the Admiralty will themselves move for a Select Committee on this great subject. I will not detain you any longer, but I think I may venture to say that your approbation is unanimously accorded to Captain Colomb for his very able lecture.

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[1] The lecture has been published in pamphlet form, price 1*s*., and may be obtained of Mitchell and Co., 39, Charing Cross, and W. H. Smith and Co., 189, Strand.

Friday, May 6, 1881.

ADMIRAL SIR ERASMUS OMMANNEY, C.B., F.R.S., Vice-President, in the Chair.

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# ON THE PROTECTION OF BUILDINGS FROM LIGHTNING.

By CAPTAIN J. T. BUCKNILL, R.E.

MR. CHAIRMAN, ladies, and gentlemen, a few weeks ago, when I accepted the invitation of the Council of this Institution to read a paper on the application of lightning conductors to buildings and magazines, it never occurred to me how difficult would be the task to deliver an *interesting* paper on so special a subject, or a paper that would be of value to a purely naval and military institution. It is, however, only too true that lightning strikes soldier, sailor, and civilian alike, and that the laws which should govern the application of conductors are the same whether it be a palace or a jail, a chimney, a cathedral, or a man-of-war that has to be protected. Moreover, the immense interests jeopardized by any faulty arrangements, which might occasion the explosion of magazines, makes the subject of special importance to naval and military men. Imagine the loss to the war strength of the Empire which would be entailed by the accidental explosion of one of the large magazines at Tipner or at Priddy's Hard, with its charge of, say, 750 tons of gunpowder, or over 750 millions of foot tons of energy developed in less than one second of time, and this within a short distance of the greatest naval arsenal in the world, and a town with 120,000 inhabitants. Every building shed would be levelled to the ground, and the town would be visited as was Chios the other day. The proper application of lightning conductors to large magazines and to men-of-war is evidently therefore a matter of importance to us all.

Electricity exists in two distinct forms, the static and dynamic, but the word static thus applied is somewhat misleading, because electricity (like heat) is now recognized to be a form of matter in motion, whether in the state of potentiality as in a thunder cloud, or in the state of activity (the work-producing state) as in lightning.[1]

How the former is produced is still conjectural, although a multitude of theories have been propounded.[2]

[1] Electrical potential, or that which produces an electrical current (just as a head of water produces a water current), is measured in units called *volts*. One Daniell's cell produces 1·1 volts.

All substances resist the passage of an electric current. The unit of this resistance is called an *ohm*. 130 yards of No. 8 B.W.G. iron wire offer about 1 ohm of electrical resistance. One million ohms is termed a *megohm*.

The unit quantity of electricity is called a *farad*, and is the amount which can be driven through a resistance of one megohm in one second by one volt.

The unit current is called a *weber*, and is one farad per second.

[2] Such as evaporation, vegetable growth, friction of the wind against the earth's surface, &c.

In whatever manner the electricity is produced, the thunder clouds act as collectors; and more than this, when the surface of the earth beneath them is not far distant, and is composed of fairly good conducting media, the earth, the clouds, and the intervening air form huge condensers—the electrified clouds acting by induction upon the earth, and the latter reacting upon the cloud.

Now the amount of electricity of a given potential which a cloud is capable of receiving depends firstly upon its size, the amount varying directly as the linear dimensions of the cloud; and, secondly, upon the intensity of inductive action of the earth's surface, the cloud's power of receiving electricity being greatly increased thereby.

For example, a cloud of given dimensions at an altitude of 300 feet could be charged by 80 times the electricity that would charge it were its altitude increased to four sea miles.

For a similar reason a cloud over a conducting area could be charged much more highly than the same cloud at the same height over a non-conducting area.

One of the most remarkable of the phenomena connected with electricity is the mutual attraction of bodies charged with electricity of opposite sign, and the mutual repulsion of bodies charged with electricity of like sign. Now the charges on inducing and induced surfaces are always of opposite sign. The bodies possessing these surfaces consequently attract each other. If, therefore, thunder clouds be driven by the wind or otherwise over portions of the earth's surface which vary considerably in their conducting power, they will be attracted to those regions which from their conductivity present the greatest facilities for inductive action; and this, in spite of the mutual repulsion of the clouds; just as the numerous admirers of a beautiful woman, although hating each other, are attached to her.

Now it generally happens that the thunder clouds in a storm are sufficiently numerous to cover both favourable and unfavourable areas of the earth's surface, and, as little or no inductive action occurs over the latter, but very considerable action over the former, the electro-static capacities of the clouds become greatly altered, and lightning plays from cloud to cloud, until those which are situated over the earth's conducting surfaces become so highly charged that the electricities are able to overcome the resistance of the intervening air and to unite across it by what is termed the disruptive discharge. This is lightning.

I have been thus particular in describing the action produced by the earth's surface upon thunder clouds, because the somewhat important conclusion must be arrived at, that lightning is most to be feared by those who live on well-conducting areas, even of low elevation; and that lightning is least to be feared by those who live on non-conducting areas. This is shown on plate, Fig. 9, where the distribution of the electrical charge is shaded in. The cloud over the Portsdown Hill, although nearer to the ground, is much less highly charged than the cloud over Portsmouth and Spithead, because the former presents a non-conducting area and the latter a conducting area. This electrical distribution is of considerable importance, and it shows that it is much

Fig 1. Fig 2 Fig 3

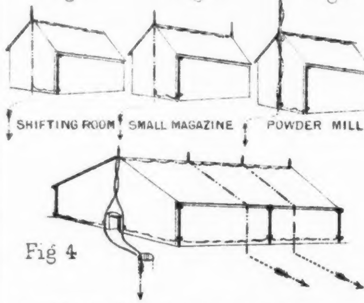



Fig 4

PRESENT W.O. INSTRUCTIONS

ARRANGEMENTS FOR MAIN MAGAZINES

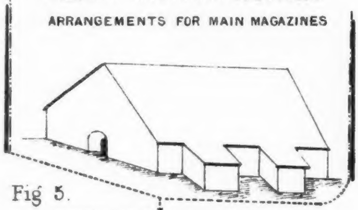
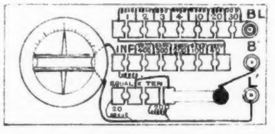


Fig 5.

FRENCH 1823 INSTRUCTIONS

Fig. 7.




BUCKNILLS ARRANGEMENT
FOR TESTING BY
WHEATSTONES BALANCE

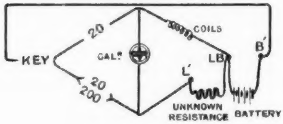
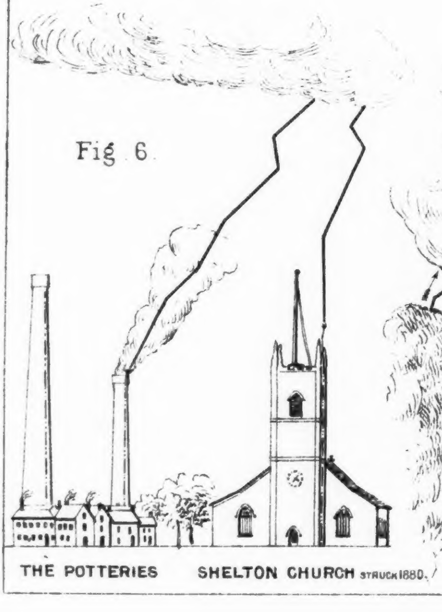



Fig 8.

Fig 6.



THE POTTERIES SHELTON CHURCH STRUCK 1880.

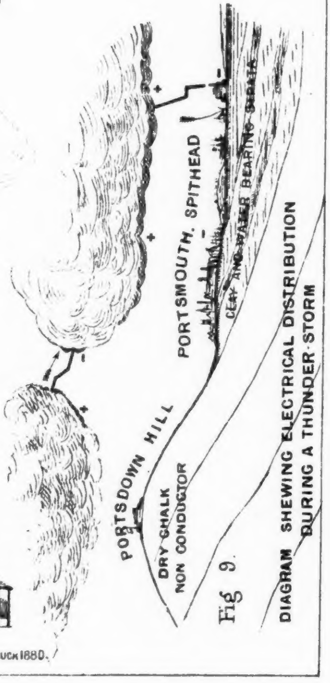



Fig 9.

DIAGRAM SHEWING ELECTRICAL DISTRIBUTION DURING A THUNDER-STORM

more necessary to provide lightning conductors for buildings situated upon a damp clay or boggy bottom than for those on a chalk down.[1] This is very convenient, for it is almost impossible to make an efficient earth connection in the latter situation.

As before stated, disruptive discharge constitutes a lightning flash. Immediately before the stroke the particles of air are subjected to a high strain by static induction, producing a polar tension which is proportional to the square of the potential. Faraday's experiments proved this, as well as the fact that the stroke tends to traverse the air in the direction of such polarity. The tendency of lightning is therefore to strike in a direction normal to the earth's surface.

But there is another mode by which thunder clouds are discharged, viz., by the brush discharge.

Electricity of high potential leaks, as it were, from conductors which are provided with projections in the nature of points, where the distribution of electrical density is greatest, a stream of electrified air being thrown from each point, and the charged conductor robbed by continuous streams of its electricity in this manner.

Although the brush discharge is frequently so intense as to be luminous to a height of 6 or 8 inches, it is not attended with any appreciable heat. Its action should therefore be fostered, as it often wards off a dangerous stroke of lightning by neutralizing the opposing electricities in a harmless manner.

It has been observed so late ago as 1758 by a Mr. Wilcke, that a thunder cloud, in sweeping at low elevation over a forest, not unfrequently appears to lose charge without the occurrence of lightning. The under surfaces of such clouds at first present a serrated or tooth-like appearance, which gradually disappears, the teeth retreating into the cloud, and finally the cloud itself rising away from the forest.

In such cases the numerous points on the branches of the trees present facilities for the brush discharge on an extended scale.

To illustrate this action, an experiment was made by Franklin, as follows:—A very fine lock of cotton was suspended from the conductor of an electric machine by a thread, and other locks were hung below it; on turning the machine the locks of cotton spread forth their fine filaments like the lower surface of the before mentioned thunder cloud; on presenting a point which was connected to earth below them, they shrank back upon each other, and finally upon the conductor.

But to return to the lightning. Just as a certain amount of water falling through a difference of level produces a definite amount of energy, so a certain amount of electricity falling through a difference of electrical potential produces a definite amount of energy. It is known that if $p$ be the potential and $q$ the quantity of electricity in a flash, the work done during the stroke is $\frac{1}{2}qp$. Now the duration of the illumination of a stroke is rather less than the 10,000th part of a

[1] At Portsmouth it has been noticed that although severe thunderstorms often occur in the vicinity, the clouds move round and seem to avoid the Portsdown Hills, which are of chalk and possess few trees.

second,[1] and although $q$ is small (Faraday said not more than would decompose a single drop of water), $p$ is so enormous that the flash is often capable of decomposing a million drops of water in series. The potential can be calculated approximately, because it is known that 10,000 volts will spark across a little more than half-an-inch at ordinary atmospheric pressure; and, as the sparking distance varies as the square of the potential, a flash of lightning 1,000 feet long must be impelled by an electrical potential of $1\frac{1}{2}$ millions of volts or thereabouts. This is only approximately accurate, because the mean atmospheric pressure would be less than that at the earth's surface, and therefore a correction should be made, as the pressure of the atmosphere decreases very rapidly with altitude and the sparking distance increases very rapidly with decrease of atmospheric pressure. The work $\frac{1}{2}qp$ done by a flash of lightning is used up in the disruption of the air, in the destruction of non-conducting solids that obstruct its path, in heat, in light, and in chemical decomposition. Ozone is always produced during thunderstorms. All that can be done to protect buildings from its destructive action is (first) to attract the lightning to another spot if possible, and (second) to arrange that even if the building be struck, the work shall be given out at other portions of the path of the stroke. To do this it is necessary to provide a sufficient conducting channel or channels to convey the electricity past the buildings from the air to the ground.

Firstly, let us examine the methods which have been pursued for attracting lightning away from the building which it may be desired to protect. The French Académie des Sciences has issued information concerning lightning conductors on different occasions, the several instructions having been the results of the labours of various Commissions of celebrated physicists.

In the first instruction, 1823, with Gay-Lussac as reporter, the rule is laid down that *a conductor will effectually protect a circular space whose radius is twice the height of the rod*, and it is stated to be in accordance with calculations made by M. Charles.

Accordingly we afterwards find in the same instructions that magazines should be protected in the manner shown on Fig. 5, the wording being: "The conductors should not be placed on the magazines but " on poles at from 6 to 8 feet distance. The terminal rods should be " about 7 feet long, and the poles be of such a height that the rod may " project from 15 to 20 feet above the top of the building. It is also " advisable to have several conductors round each magazine."

In 1854, however, the next Commission, with M. Pouillet as reporter, no longer supported this rule. The report says:—

" At the end of the last century it was a generally accepted opinion that the circle " protected by a conductor possessed a radius equal to twice the height of the point.

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[1] This fact has been distinctly proved by experiments with revolving chequered discs. Wheatstone's classical experiment proved that the duration of the luminosity of the spark from an electrical machine is about the 24,000th of a second. The longer duration of luminosity in the case of lightning is probably due to the higher temperature to which the particles of the di-electric are raised by the stroke, and their consequent more tardy return to a non-luminous condition.

"The Instruction of 1829 (Gay-Lussac, *rapporteur*) having found that practice "established, adopted it with certain reservations. . . . These rules . . . rest "on much that is arbitrary." . . . "and they cannot be laid down with any "pretence to accuracy, since the extent of the area of protection in each case is depen- "dent on a multitude of circumstances."

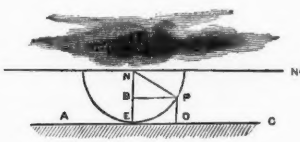
It is the more necessary to make this quotation, because an attempt has recently been made by Mr. Preece to revive the theory in a modified form. In a paper which he read before the British Association last year he attempted to prove that—

"*A lightning rod protects a conic space whose height is the length of the rod,* "*whose base is a circle having its radius equal to the height of the rod, and whose* "*side is the quadrant of a circle whose radius is equal to the height of the rod.*"

His argument was similar to, but not of such general application, as that used by M. Lacoine in a somewhat remarkable paper read 20th June, 1879, before the French Société de Physique, from which the following is extracted:—

"Experience shows that a thunder bolt has a tendency to fall on the metallic "portions of a building. If then, by the assistance of a lightning conductor we are "enabled to protect a certain metallic surface, much more therefore will the same "conductor protect the same surface if non-metallic.

Fig. 10.




"Let N, Fig. 10, represent a thunder cloud situated over the surface AC to be pro- "tected. Assume that the cloud is at such a distance from the point P of the "lightning conductor PO, that the circle described from N as centre with NP as "radius will be tangential to the surface AC. Then the cloud will be equally "attracted by the points P and E,[1] because these points are at the same potential, "this rule having always been admitted in all the instructions of the Académie

---

[1] This is open to doubt; the electrical charge on the cloud is attracted by the induction of an opposing *surface*, the total attraction being proportional to the sum of the tubes of force existing between the two opposing surfaces, charged by inductive action. To assume that the charge on a thunder cloud is concentrated at a single point is not in accordance with the circumstances of the case in nature.

Faraday's experiments have conclusively proved that static induction polarizes the particles or molecules of the interposing di-electric, and that dynamic currents tend to traverse the same by disruptive discharge in the direction of the said polarity.

Assuming therefore that a lightning flash from the charged surface NN′ occur at N, it will have a tendency to follow the direction NE rather than the alternative route NP, because polarity exists between NE to a greater extent than between NP.

This consideration will cause the theoretical circle of protection advocated by M. Lacoine to be considerably diminished when the charged cloud lies low, but when the cloud is at a considerable altitude NP becomes more nearly normal to the surface AC, and more nearly parallel to the direction of polarity of the atmospheric particles.

"Française. Consequently every point on the surface AC within the circle with "radius OE will be protected, but every point outside E towards A would be "unprotected.

"Hence the radius of protection $r = \sqrt{NE^2 - NB^2}$, NE being the height of "cloud above the ground, NB being the height of cloud above the conductor.

"It is enough, then, to know the height of the thunder cloud, to know the radius "of action of a certain conductor.

"By several years' observation, and by direct measurement, the average height of "thunder clouds could be obtained, and the mean value of $r$ for any given con-"ductor deduced therefrom.[1]

Mr. Preece does not work out any such formula, but bases his rule on an assumption that a thunder cloud would never be nearer to the earth than the height of the lightning rod. This is open to question, as very low-lying thunder clouds may be driven by the wind into the neighbourhood of lofty conductors that command the clouds, and this is corroborated by a case recorded in Mr. Anderson's excellent book on lightning conductors, page 67, where the belfry of an edifice, 115 feet high, "remained standing out clear above the electric cloud" whence issued lightning that killed two priests near the altar of the church. As a single application Mr. Preece's rule comes at once from M. Lacoine's formula.

It is perhaps important to bear in mind these theories concerning the area of protection given by conductors, when it is necessary to fix a few conductors on buildings of considerable extent, such as barracks, hospitals, &c., but sufficient reliance cannot be placed upon the rule to enable us to consider the protection to magazines, as shown on Fig. 1, and already alluded to, as efficient.

The area of protection afforded by a conductor depends much more upon the efficiency of the earth connections than upon the height of the terminal point, and in proof thereof many instances might be cited. For example, in the case of Shelton Church, in the Potteries, which was struck on the 10th June, 1880, the tower, about 16 feet square, is surrounded by four pinnacles 16 feet above the roof, which is nearly flat and covered with slates, with lead guttering and ridges. From the centre of the roof springs a large flagstaff, about 40 feet high (see Fig. 6), secured to the tower in the upper chamber 20 feet below the roof by large cross beams unconnected, except by stone-work, with the clock-works, bells, and gas pipes in the chambers of the tower. A copper wire rope $\frac{5}{8}$ inch diameter is fitted to one pinnacle and taken direct to earth. Although the flagstaff projects some 20 feet above the conductor, and is distant only 10 feet, a very heavy stroke of lightning, which caused much alarm, and which was seen to fall upon the tower, struck the conductor, knocked the point slightly out of the perpendicular, and passed off by it innocuously. In this case a good con-

[1] As the height of thunder clouds varies enormously, the values for $r$ would range between proportionately wide limits, and the *mean* value of $r$ obtained by M. Lacoine would seem to possess no definite or practical utility. If, however, the observations were directed to observing the minimum altitudes of thunder clouds in each locality (the altitudes will be found to vary with the locality), the smallest areas of protection given to conductors there situated could be approximately established.

ductor, well connected to earth, protected something higher than itself, but not well connected to earth.

Again, Sir William Snow Harris mentions a chimney at Devonport which, although provided with a conductor, was struck on the other side, and shattered down to the level of a metal roof below. Here the conductor must have been badly connected to earth, and was useless.

Moreover, the safe area rule may be upset in practice by all sorts of accidental circumstances. Thus, a house within the theoretical circle of protection given by a church spire close at hand might be struck if the line of least resistance from cloud to earth were afforded by a column of rising smoke from the kitchen fire, and the shorter of the two chimneys in Fig. 6 would most assuredly be struck, for a similar reason, although it is within the theoretical cone of safety of the taller chimney as fixed by Mr. Preece.

In short, if thorough protection be desired for any building it is necessary to put a conductor or conductors upon it.[1]

Let us now examine the manner in which conductors should be applied.

Churches and dwelling-houses of ordinary dimensions, factory chimneys, monumental columns, &c., need but one conductor led from the most lofty point to the ground, to which a thorough efficient earth connection (to be described presently) must be given. As a rule it is the best plan to fix the conductor externally, in which case it should be connected to all *external* metal surfaces, but *not* to any masses of metal wholly within the building. It should be fixed to the exterior by strong cramps of iron or other metal, and provision should be made for its expansion and contraction due to differences in temperature. It should be continuous from top to toe. It should possess a proper amount of conducting power per unit of length.

As regards the last mentioned and most important matter of conductivity, the last French instructions, dated 14th February, 1867, state that there is no case on record where lightning has fuzed a square bar of iron having a side of 0·6 inch, or a section of 0·36 □″—and

[1] A lamentable result of the practice of placing lightning conductors distant from a building occurred at Compton Lodge, in Jamaica, the residence of J. Senior, Esq. A lightning rod, of small dimensions, of iron, had been set up within 10 feet of the south-east angle of the building, as used to be the practice with gunpowder magazines, on the assumption that the rod would attract the lightning and secure the building. So far from this, the building itself was struck in a heavy thunder storm, 28th July, 1857. The south-east angle was shattered in pieces; the escape of the family appears to have been miraculous; whilst the lightning rod, 10 feet distant, remained untouched. If this building had been a deposit of gunpowder, it would certainly have blown up.

Sir Wm. Snow Harris said:—"To detach or insulate the conductors is to run "away from our one principle, which is, that the conductor is the channel of com- "munication with the ground, in which the electrical discharge will move in *prefer- "ence to any other course.* To detach or insulate the conductor is to provide for a "contingency at once subversive of our principle. Is it possible to conceive that an "agency which can rend large rocks and trees, break down perhaps a mile of dense "air, and lay the mast of a ship weighing 18 tons in ruins, is to be arrested in its "course by a ring of glass or pitch, an inch thick or less, supposing its course were "from any cause determined in that direction?"

square iron conductors 0·8-inch side are recommended, which gives a section of 0·64 □″. Also Sir William Thomson considers that a round iron bar 1″ diameter, would form a very safe protection for magazines; this would be about 0·77 □″ sectional area. It would appear that continuous iron conductors weighing 6 lbs. per yard would be quite safe, as shown in the following table:—

TABLE A.

| | Iron Conductors. | | |
|---|---|---|---|
| | Side. | □″ | lbs. per yard. |
| Limits of safety—French instructions.. | □ 0·6″ | 0·36 | 3·6 |
| Conductors recommended by ditto— | | | |
| from | □ 0·75″ | 0·56 | 5·6 |
| to | □ 0·8″ | 0·64 | 6·4 |
| Sir William Thomson recommended .. | ○ 1·0″ | 0·77 | 7·7 |
| New W.O. Instructions .. .. .. | .. | 0·8 | 8·0 |
| Now proposed for general purposes .. | .. | 0·6 | 6·0 |

Now iron has about one-seventh, and good commercial copper about four-fifths of the conductivity of *pure* copper. Hence iron has about one-sixth conductivity of good commercial copper. A safe conductor in good copper must therefore weigh 1 lb. per yard.

It is, however, inconvenient to specify for a conductor either by sectional area or by weight per yard, because different samples of metal, and especially of copper, vary considerably in their conducting power. See Table.

Table of conducting power of different descriptions of copper:—

TABLE B.

| | |
|---|---|
| Pure copper .. .. .. .. .. | 100 |
| Lake Superior .. .. .. .. .. | 98·8 |
| Commercial .. .. .. .. .. | 92·6 |
| Burra Burra .. .. .. .. .. | 88·7 |
| Best selected .. .. .. .. .. | 81·3 |
| Bright wire .. .. .. .. .. | 72·2 |
| Tough .. .. .. .. .. .. | 71·0 |
| Demidoff . .. .. .. .. | 59·3 |
| Rio Tinto .. .. . .. .. | 14·2 |

Temp. about 15° C. or 60° F..

Imagine a conductor made of Rio Tinto copper (!) No doubt many exist.

A limit of electrical resistance per unit of length should therefore figure in any contract for a lightning conductor, and for the conductors already recommended this limit would be 0·3 ohm per 1,000 yards, or 0·03 ohm per 100 yards, at 60° Fahrenheit or 15° C.

This would be obtained from iron wire rigging ropes weighing 6 lbs.

per yard, or from copper (equal to 80 per cent. pure in conductivity) ropes weighing 1 lb. per yard.

When two "earths" are used, and the conductor is carried up one side and along the ridge and down the other side of the building to be protected, it is evident that the conductor may be reduced in power by one-half, but no further reduction can be made when a still greater number of "earths" are used, because the lightning may strike the system of conductors at any point. A 3-lb. iron (or a half-pound copper) rope is therefore the smallest that should ever be used in any situation.

There is much difference of opinion as to whether iron or copper is the better material for lightning conductors.

The French use iron almost exclusively, and Sir W. Thomson prefers it to copper.

For the same money the same conductivity can be purchased in either metal (iron being one-sixth of the price and one-sixth of the conductivity of copper), and iron has the following advantages:—

(*a.*) The mass of an iron conductor being greater than that of a copper conductor of equal conductivity, it is heated less by a given current of electricity.

(*b.*) The fuzing point of iron (2,786° F.) is much higher than that of copper (1,994° F.).

(*c.*) Iron is more constant in its conductory power than copper of different samples.

(*d.*) A conductor made of iron is not so liable to be stolen as copper, and being so much the stronger is therefore less liable to be broken, accidentally or otherwise.

(*e.*) A copper conductor if connected to a cast iron water supply pipe (to form an "earth") produces galvanic action, to the damage of the pipe.

On the other hand, a copper conductor lasts longer in smoky towns or near the sea shore, where the air rusts iron quickly, and being of much *smaller* size it does not interfere so much with architectural effects. But Sir W. Thomson has suggested that iron conductors should be treated boldly by architects, and brought into prominence purposely and artistically, and the late Professor Clerk Maxwell recommended that in the case of new buildings the conductors should be built into the walls. They would then not only be hidden but protected from the weather, from the British workman carrying out repairs, and from the thief.

As regards the liability of iron to rust, galvanizing is in most situations a sufficient protection, and in smoky towns an iron conductor should be painted periodically.

On the whole, therefore, the advantages of iron outweigh those of copper so considerably, that the employment of copper in lightning conductors should be the exception instead of the rule.

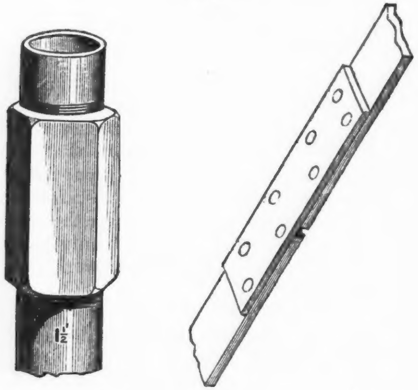
Those who make, supply, and apply lightning conductors in this country, nevertheless, invariably recommend copper; and it is quite difficult to convince them to the contrary.

Another point I notice is that large conductors are always recommended for lofty buildings, and smaller conductors for smaller buildings, and the same for masts of ships. This is unscientific and wrong. The stroke of lightning falling on a short conductor is no less powerful than the stroke that falls on a lofty conductor; indeed the chances are in favour of the shortest conductors receiving the heaviest strokes, if they are struck at all. On costly and important buildings, the proper course to pursue is to increase the number of conductors, and of the earth connections, the limit of electrical resistance between any possible striking point and earth being kept below what is fixed upon as the point of safety, viz., 0·3 ohm per 1,000 yards.

We will now examine the question as to the best *form* of conductor. Mr. Preece has investigated this subject, and by permission of Dr. Warren de la Rue carried out in that gentleman's splendid laboratory a series of experiments on the best sectional form for lightning conductors. The results were communicated to the British Association at Swansea last year. He found that ribbons, rods and tubes, of the same weight per foot, were equally efficient.

The application of rods and tubes necessitate frequent joints, generally made by means of screw collars. I have found by electrical tests that these joints after long exposure to weather offer very high resistances; especially so in copper conductors. For instance, at Tipner magazine a screwed joint in a large tubular copper conductor tested 10,000 ohms, and a riveted joint in a ribbon conductor on a battery in the Isle of Wight 700 ohms. These joints could not be moved by hand, and were apparently quite tight.

Fig. 11.



Ribbons of *copper* are now made in long continuous pieces (as much as 70 or 80 feet in one length), and can be applied to irregular architectural outlines, but the joints, although less frequent than with rods and tubes, are open to the same objections. The copper ribbon, how-

ever, possesses one decided advantage, viz., that by the introduction of suitable bends, the expansion and contraction from heat and cold can be allowed for. Iron conductors, when in the form of tubes, rods, or ribbons, are difficult to apply, and must possess a number of joints. Moreover, in long conductors, compensators to allow for expansion and contraction by heat and cold have to be introduced. In order, therefore, to obtain with iron the necessary continuity and pliability, it is best to resort to the wire rope, which form is already very generally employed for copper conductors. Pliability can be obtained in several ways—

1. By using small wires.
2. By making the rope *flat*.
3. By using a hemp core with the round rope.

It is not advisable to make the iron wire ropes with very small wires, because oxidation destroys such a rope rapidly if through carelessness the conductor be left unpainted. A fair amount of pliability can be obtained with a round iron rope 6 lbs. per yard if the wires are about No. 11 B.W. gauge, and arranged in six strands of seven wires each round a hemp core, thus producing a rope about $3\frac{3}{4}$ inches in circumference.

But there are few situations in which two ropes of half the size could not be more readily applied; and I think the double rope, if taken up on one side of a tower and down on the other, in one continuous length, has many advantages.

Where a single conductor is desired, the best for general purposes is probably a flat iron wire rope about $2\frac{1}{4}'' \times \frac{1}{2}''$ (11 lbs. per fathom), or $2\frac{1}{2}'' \times \frac{1}{2}''$ (13 lbs. per fathom). The round ropes cost from 21*s*. to 24*s*. a cwt., or about 2*s*. 6*d*. per fathom for a 12-lb. rope; and the flat ropes 33 per cent. more, or add one-third.

The next question that presents itself is concerning the terminal point, and a good deal of nonsense has been written about it. Points made of silver or of copper, points covered with platinum or with gold, points of so many millimetres in height and diameter, and possessing certain exact forms, have been proposed, and rejected or adopted as the case may be.

The height of the points above the surrounding roof or tower to be protected has also been much debated with very little profit, for to this day many of the rods erected on the Continent are made much longer than is necessary.

It is a good plan to carry conductors on lofty rods high above powder mills, flour mills, and petroleum oil wells; but these are exceptional cases, the air close to the buildings being frequently charged so as to be dangerously explosive.

The English practice of using a short rod in most situations is a reasonable plan, the rod being placed on the highest part of the building. The rod should be made of the same metal as the conductor, and the connection formed with bolts and afterwards run in with molten zinc or solder. The weight of the rod per foot should be the

same as the conductor. The top of each rod should be provided with several points, (*a*) because the gathering power is increased thereby, and the chance of lightning striking other things in the immediate vicinity of the conductor is proportionately diminished; (*b*) because the top of the rod is less likely to be fuzed when struck, the stroke being divided between the various points; and finally (*c*) because the brush discharge is facilitated.[1]

Another plan is to carry the wire rope up the side of the rod, which in this case might have one point, the wires being opened out to form a brush-like arrangement just under the point. The wire rope and the rod should be bound together with wire and connected with molten zinc.

We must now pass to the foot of the conductor, and here we enter upon the most difficult part of our subject. The earth connections of a lightning conductor constitute the most important portion of the whole arrangement. If the electrical resistance of the earth connections be high, a conductor, perfect in all other respects, may fail, some alternative and perhaps dangerous route being taken by the lightning discharge. It is difficult to fix the limit of maximum resistance of the earth connections.

*The Académie des Sciences* recommends an iron earth plate, consisting of four arms on a central bar, or five arms in all, each 2 feet long and of square section 0·8 inch side, thus presenting a combined surface of 2·6 square feet, to be immersed in water in a well that never dries.

Again, Mr. Anderson, in his book before referred to, says that—

> "When a conductor is taken deep enough into the ground to reach permanent "moisture, the single rope touching it will be quite sufficient. But when the permanency of the moisture is doubtful, it will certainly be advisable to spread out "the rope like the fibres in the root of a tree."

Here a few square inches touching permanent moisture is considered sufficient.

Again, Professor Melseus used three earths for the Hôtel de Ville at Brussels—one the gas main, another the water main, and the third a cast-iron pipe, nearly 2 feet diameter, sunk in a well and giving 100 square feet of surface to the water, which was rendered alkaline with lime to prevent oxidation. The total surface of these three earth connections amounts to more than $2\frac{1}{2}$ millions of square feet!

As opinions differ so greatly concerning the surface required for the earth connections, it will be necessary, before laying down any rule, to give some of the reasons upon which it is based.

I must ask you to examine Table (C) of Resistances, which has been compiled from various authorities, and which deals with such enormous differences that it can only be regarded as approximately accurate.

[1] Sir William Thomson's opinion:—"A fork or brush of three or four points at "the top of a lightning rod is probably in general preferable to a single point; but "of what practical value this preference may be I cannot tell for certain, although I "think it may be considerable."

TABLE C.—*Of Resistances.*

| Substance. | Comparative Resistances in Ohms. | | Effective Section. |
|---|---|---|---|
| | Copper unity. | Iron unity. | |
| | | | sq. in. |
| Pure copper .. .. .. .. | 1·0 | .. | .. |
| Commercial copper .. .. .. | 1·17 | 0·2 | 0·2 |
| Iron wire .. .. .. .. | 7·0 | 1·0 | 1 |
| | | | sq. ft. |
| Carbon .. .. .. .. .. | 2,500 | 360 | 2½ |
| Coke, variable with the sample, about | 3,000 | 400 | 3 |
| | 4,000 | 600 | 4 |
| Sat. sol. sulp. zinc .. .. .. | 6,000,000 | .. | .. |
| Salt (sea) water .. .. .. } | 10,000,000 | .. | 10,000 |
| Approximately only .. .. } | 15,000,000 | .. | 15,000 |
| Water (spring) .. .. .. .. | 2,800,000,000 | .. | 2,800,000 |
| „ distilled .. .. .. .. | 6,754,000,000 | .. | .. |
| Dry earth .. .. (practically) | Infinity .. | .. | .. |

We might state the figures against water in this table thus:—

The electrical resistance offered by a cylinder of spring water 1 yard long is as great as the resistance offered by a cylinder of copper of equal diameter, but seven times longer than the distance of the moon.

The study of this table evolves some rather curious considerations. Let us call 1 square inch of iron its efficient section[1] or conductive capability for carrying off a stroke of lightning. Then the efficient sections of carbon, of water, &c., are as shown in col. 4 of table.

Now the practice in the War Department has always been to give joints in conductors a surface of about six times the sectional area of the conductor. This is a very good rule, and is borne out by the French practice, where even with soldered joints, 6 square inches of surface is laid down as necessary at each joint in an iron conductor. An obvious corollary to this rule is that when a conductor is made of two metals (end to end) the joint must have a surface equal to six times the efficient section of that conductor of the two joined which possesses the lowest conductivity. The efficient section of the better conductor ought not in any way to govern the amount of surface of the joint. Thus copper to iron requires a joint of 6 square inches, the same as would be required by iron to iron. In short, the joints should be made of such a size as to prevent the conductors of lower conductivity being damaged by the lightning.

A copper to copper joint only requires 1 square inch of surface, but it is generally convenient to give more.

Now the earth connection is really a joint, a very difficult joint to

[1] This has already been shown to be rather less than a square inch of solid iron.

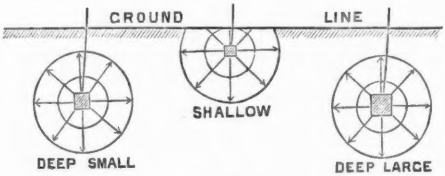
make well, and one that should follow the rules of other joints, *unless we can show good reason to the contrary.*

It is found that increasing the size of an earth plate does not proportionately decrease the electrical resistance. A limit of size is soon arrived at, beyond which it is useless to go. "In the sea this limit is "quickly reached."—(Culley.)

Culley states that if a plate containing 1 square foot of surface give a resistance of 174 ohms, a plate of 4 square feet will give 140 ohms, and so on, a reduction of only 20 per cent. in resistance being obtained by quadrupling the earth plate surface.

The explanation that suggests itself as probable is that the electric current is distributed through the humid ground by an ever-increasing sectional area (often by an hemispherical surface), thus arriving at the efficient section for a water conductor of 2 millions of square feet (*see* Table C), at the small distance of 200 yards, or thereabouts,[1] from the earth plate; and this is borne out by the fact, noted by Culley, that the resistance depends to a certain extent upon the depth at which the plate is buried. Thus, a deep plate would disperse its charge in all directions by an ever-increasing spherical surface up to the limit of a sphere whose radius is equal to the depth of the plate underground, and afterwards by a segment of an ever-increasing sphere, which segment would always in this case be larger than, but would gradually approximate, the hemisphere. These actions are roughly shown on Fig. 12:

Fig. 12.




Culley states that the resistance alters with the depth at which the earth plate is buried, as follows:—

| | | |
|---|---|---|
| 4 inches | .. .. .. | 100 ohms. |
| 10 ,, | .. .. .. | 90 ,, |
| 40 ,, | .. .. .. | 80 ,, |
| 80 ,, | .. .. .. | 77 ,, |

It would appear, therefore, that little is to be gained by increasing the surface of junction between the earth plate and the earth (1) beyond the amount required to ensure that the resistance to earth at foot of conductor is less than the resistance to earth through possible alternative routes in the vicinity of the conductor, and (2) beyond the amount

[1] In an arid plain with a dry subsoil, the surface of which was wet by rain only to a depth of one inch, the efficient section of a water conductor would not be reached at a less distance than 50 miles.

required to prevent damage to the conductor by the flash of lightning when it leaves for earth. It is evidently impracticable to give a surface of some millions of square feet to the earth connections, and if it were practicable, the foregoing considerations prove, I think, that it is not necessary to do so.

The difference in the conductivity of iron and water is so enormous that an intermediary appears to be very desirable. Carbon is eminently suited to act in this manner, especially if used in the cheap form of coke or ashes. The minimum effective section for coke is about 4 square feet, the iron which is surrounded by coke should, therefore, have a surface of 24 square feet. Moreover, inasmuch as the contact between an iron plate, of whatever form, and coke loosely surrounding it must frequently be discontinuous, and as the conductivity of coke in a mass composed of loose particles must be very much lower than that of a solid piece, the above surface should in practice be a minimum.

The total surface may, however, be divided if a number of earths be used.

The outer surface which should be given to the coke must depend very much upon the nature of the ground; when the conductor is led into soil which cannot be regarded as permanently damp, the surface of the carbon " earths " must be increased.

As the surface of the earth connection should vary directly as the resistance per unit of area, an intermediary of coke becomes unnecessary where a conductor is led into salt water; but the conductor should still present a total surface to earth of from 20 to 30 square feet, the amount being divided between the " earths " if several conductors be connected.[1]

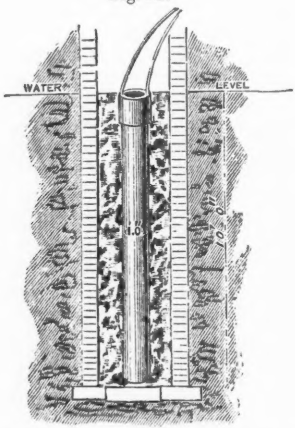
Professor Pouillet's Committee, which reported upon the application of conductors to the Louvre in 1854-55 (the said report being adopted by the *Académie des Sciences*), recommended that when permanent water is not found near the surface, two descriptions of " earth " are necessary; first, the deep earth connections to permanent water, and secondly, the shallow earth connection to the surface water. This for the following reasons: After a long drought, the " terminating plane " of action " (to use Sir William Snow Harris's term) is situated on the upper surface of the deep water-bearing strata, the induced charge being consequently collected there. After a heavy rain, however, which thoroughly impregnates the upper strata with water, the " terminating plane of action " is raised to the surface of the ground, and the induced charge is accordingly collected there. It is evident, therefore, that a perfect arrangement should in many situations provide both for *surface earths* and for *deep earths*. In some situations, however, such as the top of a chalk hill, deep earths would be of little value; whereas in other situations surface earths would be inefficient —in a well-paved town for instance, where the surface water is at once carried off by gutters and drains.

A deep earth connection can be effected in the manner shown in

[1] A 3″ (circumference) wire rope offers about 1□′ surface per 4′ run.

Fig. 13, the well being carried down 10 feet below water level in the driest seasons. The diameter of the well may be fixed at 3 feet. It should be rendered alkaline with lime, so as to protect the iron from rust.

Fig. 13.




The bottom 10 feet should have no mortar or cement in the walls, and should be filled in with blocks of coke. The iron conductors should terminate in cast-iron pipes, offering together 24 square feet of outside surface. The pipe should be galvanised to preserve it from oxidation. The dimensions of the pipe may be, length 10 feet, diameter 1 foot. The pipe may rest on the bottom of the well, in a vertical position. The best way to connect the pipe with the conductor is to have a flange at the top (all ordinary gas or water pipes have such flanges), and to rivet a small cylinder to the inside of the pipe at the upper end, thus forming a ring or annulus, into which the end of the conductor can be introduced, and the space filled in with molten zinc, the surfaces of the conductor and of the pipe having first been cleaned and painted with hydrochloric acid.

In situations where iron water supply pipes are at hand, they can be employed in place of the deep earth connections already described, but great care must be devoted to the connections. The conductor must be laid along the iron pipe for a distance of 4 feet (if an iron wire rope it should be unlaid for this distance), it must then be bound to the pipe with wire, and a metallic connection formed by means of lead, zinc, or solder. The connection should then be tarred and covered with tarred tape to prevent galvanic action.

Surface "earths" should consist of a trench filled with coke and ashes, and carried away from the walls. Clay and other soils which keep the rain-water near to the surface require shallow trenches about 1 foot deep; whereas gravel, sand, or shingle, through which the water penetrates easily, require deeper trenches, say 2 feet deep.

In each case, however, the top surface should be kept on the ground level.

The end of the metal conductor should be carried along the bottom and through the whole length of each trench. This length may in ordinary soils be fixed at 25 feet, and in very porous soils at 50 feet.

The water pipes from the roof of the magazine or building may with advantage be caused to deliver into gutters which lead to the surface "earth" trenches.

The shallow trenches, 1 foot deep, recommended for stiff soils, may conveniently be split into a V shape on plan (the conductor being split also), so that the total side surface may be equal to that given by the same length of deeper trench used with porous soils.

Important buildings and magazines provided with several conductors, may have a few deep "earths," and several shallow "earths," an "earth" of one or the other description being provided at the foot of each vertical conductor, and in order to connect the whole it is advisable to employ a horizontal conductor near the foot of the wall, but above ground in order that it may be open to inspection, such conductor being carefully connected to all the vertical conductors, and to all the metal water pipes. By this means not only is the cage principle advocated by the late Professor Clerk Maxwell and other physicists embodied, but the earth connections are connected in an efficient and reliable manner.

Sir W. Thomson considers that conductors on magazines should be spaced at intervals of about 50 feet, by which plan no portion of the building would be more than 25 feet from a conductor. This rule has been adopted by the War Department for all large magazines, and a conductor of power equal to an iron rod weighing 8 lbs. per yard has been adopted for single conductors, and of half that weight for all others. A wire rope of 4 lbs. per yard applied *as shown in diagram*, is now considered the best arrangement.

It will be seen that wherever the lightning falls a conductivity equal to, or more than, that of a single large conductor will carry the stroke off to earth.

Small magazines can be protected by one rope led to a deep "earth" at one end and to a shallow "earth" at the other, as shown on diagram.

Powder mills must be provided with lofty conductors, to guard as much as possible against powder dust in the air being ignited by the stroke.

As regards the inspection of lightning conductors, opinions vary greatly, and it was mainly in order to obtain a report on this matter that I was ordered last summer to inspect a number of conductors on magazines in the Portsmouth district. I will read a few extracts from my report. (See Appendix I.)

Before concluding this paper, I may observe that the principal object has been to prove the following points:—

1. That iron is the best metal to use in conductors.
2. That wire ropes are more easily applied than rods, ribbons, tubes, &c.
3. That conductors should be continuous, and that all unavoidable joints should be soldered.

4. That conductors should be specified in terms of electrical units.
5. That lofty conductors require no additional conductivity per unit of length.
6. That high lightning rods are only required in exceptional situations.
7. That several points are preferable to a single point.
8. That greater surface than is usual with present practice should be given to earth connections.
9. That both deep and shallow earths are required.
10. That periodical inspection is most important.
11. That the history of conductors and of former tests should be carefully recorded.
12. That electrical tests may then be of value.

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## APPENDIX I.

I have to report that, in accordance with instructions, I have made nearly 500 tests, and have inspected the whole of the lightning conductors on fortifications in the Portsmouth and Gosport Divisions of the southern district, and have come to the deliberate conclusion, after a careful study of the subject, that *with the lightning conductors erected as they are at present by W.D.*, electrical testing is of small value.

The fact that the conductors on one building test lower than the conductors on another building certainly points to the inference that the earth connections in the former case are of superior efficiency; but it does not prove it. Moreover, although the tests are sometimes of value to the inspector *when he knows the details of the earth connections from the office records*, the tests taken by themselves are frequently positively misleading, so far as the earth connections are concerned. As regards the conductors themselves, above ground, high resistance tests do not prove inefficiency when the W.O. rule that the surface of the joint shall be at least six times the sectional area of the conductor is strictly adhered to; and in this view I am borne out by Sir William Thomson's opinion, which now lies before me, viz., "that although "it would be desirable that the joints should be soldered and run in with lead, so as "to make sure of absolute contact, at the same time it is to be remarked that the "great resistance at imperfect joints is not detrimental to the lightning conductor, "because, when a discharge takes place, the imperfect joint is bridged across, and "the resistance, which is very great when tested by a feeble current, becomes practically annulled in the electric arc during discharge."

Dr. De la Rue also writes to me and says:—"The resistance of many megohms "would offer an insignificant obstacle to a lightning discharge, on account of the "extremely high potential of a thunder cloud. Consequently, a conductor would "be quite efficient, although offering a megohm resistance."

The opinion that lightning conductors with large surface joints are efficient, although offering high resistance at the joints, is also substantiated by the well-known action of plate paratonnères, as applied on the flanks of electric telegraph stations, to protect the instruments therein from the effects of strokes of lightning upon any portion of the line. These paratonnères consist of plates, in most patterns smaller than the flat joints of lightning conductors, and paraffined paper is interposed between the plates the more thoroughly to insulate the lower plate from "line." A number of these paratonnères are in store at Woolwich, and they each test from 3 to 40 megohms of resistance; yet in practice a flash of lightning is always found to pass across them to good "earth," in preference to the alternative path offered through the telegraph instrument, usually of less than 2,000 ohms. It is therefore quite erroneous to suppose that lightning always passes to earth by those paths which, *to the ordinary voltaic current*, test lowest. It, however, does

pass to earth by those paths, which *to a current of its own potential*, would test lowest. . . . . .

With regard to the conductors now existing on our magazines and fortifications, and which have been erected for the most part on sound principles, and which have never yet failed, it would appear that the periodical inspection should be performed by a thoroughly competent inspector who has studied the subject. He should be provided with drawings and record plans, and every information that can be afforded of each and every conductor in the district to be inspected. The information concerning the earth connections should be most minute and exact. He should also be provided with a light equipment for making such electrical tests as he may find necessary. If this were done, my recent experience would point to the conclusion that the electrical tests would form the least important portions of his periodical reports. . . . . .

As far as my own experience has gone, it would seem that our conductors are, with few exceptions, as efficient now as when they were first put up; but the earth connections of most of the conductors are and always were considerably below the standard. . . . . .

Although the lightning conductors at present on our magazines and forts are no doubt, so far as the conductors themselves are concerned, efficient, their efficiency could nevertheless be guaranteed with greater certainty if more modern practice were followed. . . . . .

The adoption of modern practice would at once make electrical testing of considerable value, because with *unbroken continuity* and the *best earth connection*, all conductors would test at a very low figure indeed, unless out of order. An economy would also be effected on all new works, because metal pipes and rods, with costly sliding joints to allow for expansion and contraction, would no longer be required.

As regards the testing of conductors: a few tests were taken with the three-coil galvanometer, but with no satisfactory results, as the instrument is not sufficiently accurate when used as a measurer of electrical resistance. An attempt was then made to test by means of the "earth" cells produced by the earth of the lightning conductor, which was always either of copper or iron, and a test earth of iron or copper. This gave promise at first of becoming a good test, the astatic galvanometer being employed, but the method was soon discarded from want of accuracy. It is, however, useful for the tester sometimes to discover the metal of the earth connection of a conductor, and the above method can then be resorted to. . . . .

A quarter-mile of the light insulated wire for Engineer mountain equipment (60 lbs. per mile) was cut up into three pieces, each 110 yards long and 4 ohms resistance, and two pieces each 55 yards long and 2 ohms resistance. This wire was found to answer well, and being so light, could be carried over a man's shoulder without any difficulty for considerable distances. . . . .

Two small plates (one copper and one iron) were used, their dimensions being 7 inches wide and 8½ inches long; they were of oval shape, and made of quite thin metal. A lip was formed at the top, and a hole punched in the plate 2 inches below it; a 2-foot piece of Navy demolition cable was then brought through the lip, passed through the hole, the wires cleared of insulation for 1½ inches, and the ends spread out like a fan and soldered to the plate. The lip at the top was then firmly hammered over the covered wire until it held the wire tightly. The other end of the piece of core was then stripped and the wires sweated together ready for insertion into a brass connector when required.

A number of resistance tests having been taken with the P.O. pattern resistance coils, an astatic, and service six-cell portable test battery, it was found that the tests usually ranged below 200 ohms; and I designed an instrument to test these resistances with approximate accuracy up to 200 ohms, and to measure roughly up to 2,000 ohms, the bottom plug being placed in the "× TEN" hole when measuring the higher resistances. The whole arrangement weighs less than 6 lbs. when the battery is charged; its dimensions, moreover, are only 9″ × 5¼″ × 6″ over all, and the method of using it can be taught to any intelligent man in a few minutes. The instrument shown on Fig. 7 is the latest and improved pattern, and has a range up to 1,110 ohms, when testing direct by steps of 1 ohm; and to 11,100 ohms by steps of

10 ohms, when using the multiplying hole marked "× TEN." In testing a conductor's "earth" the wire to the conductor would be taken to terminal L', one pole of the battery and the wire to the test earth plate to terminal BL, and the other pole of the battery to terminal B'; the plugs on the upper row of brasses would then be moved about until no deflection is produced upon the galvanoscope on the battery key being pressed down, the bottom plug being placed in the "EQUAL" hole. If, however, the resistance to be found is more than 1,110 (shown by above trial) the bottom plug is moved to the "× TEN" hole, and a balance obtained and recorded.

The silver chloride battery is used on account of its small weight, and when kept in a dark box it is fairly permanent. All the connections are permanently made, which simplifies the testing very much indeed. These connections are all shown in the diagram, and will be understood by any electrician. The sketch on Fig. 8 shows the electrical arrangement a little more graphically. Everything is done permanently, except the connection of the unknown resistance $x$ between terminals L' and BL, the plugging at R, and the insertion of the EQUAL or ×TEN plug. The tests taken in the Isle of Wight were performed with the instrument. It saved much time, being very rapid in action and easily set up. It has also been checked for accuracy by a series of tests at Woolwich with satisfactory results.

A special clamp was found to be useful in connecting the test wire to the conductors, a small clean spot being produced by a file for the end of the screw to seat upon. When the leads had to be connected for long stretches the naval pattern brass connectors were used.

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## APPENDIX II.

### *Extracts from a Memorandum by Colonel H. Schaw, R.E.,* 1879, *on Lightning Conductors.*

"The testing of the electrical resistance of a system of lightning conductors will "generally present great difficulties, because the ordinary means of allowing for "expansion and contraction by slotted joints destroys the metallic continuity of the "conductors, and introduces a variable resistance of oxides and foreign substances "between the slipping surfaces.

"This resistance will generally be very much in excess of that of the whole length "of the conductors; it is, however, of little or no consequence when opposed to "electromotive force of such high tension as a lightning discharge, which will easily "pass the obstruction as exemplified in the form of lightning protector used by "Messrs. Siemens for electric telegraph stations, which is formed by two brass "plates with roughened surfaces placed face to face, but prevented from coming into "contact by a thin strip of mica.

"If the line wire is struck by lightning, the discharge takes place to earth through "the protector, the two plates becoming oppositely charged by induction, and a spark "passing between them. . . .

"The ordinary currents have not a sufficient tension to pass the air space in the "lightning protector, but go to earth through the more circuitous route of the "instrument.

"The test by simple inspection would seem to be the best for the conductors "above ground. A resistance test could only be applied with advantage where there "were no slip joints, and where the conductors were difficult of access.

"As regards the earth connection, simple inspection may frequently be the easiest "and most satisfactory test also. It is known by experience that 10 superficial feet "of metallic conductor in contact with *wet earth or water* is sufficient to carry off "safely any discharge of lightning. If then we can by inspection ascertain that in "*dry summer weather* we have such a connection we may be satisfied. Should it be "difficult to inspect, then the electrical test should be used, and I should prefer the "Wheatstone balance test. . . .

"It might happen that the connection between the conductor and the plate, or "tube, or mass of metal forming the earth was imperfect, owing to oxidation. In "such a case the resistance would appear considerable, yet in reality the connections

" might be practically good as regards lightning, as a spark would pass from the " conductor to the plate, &c., and from its large surface in contact with water it " would escape freely and harmlessly. . . . . .

" Hence I consider that in all possible cases inspection is the best test, but that " electricity carefully used may assist the inspection in cases where the earth connec- " tion is difficult to get at.

" It is most necessary that tests or inspections of earth connections should be " made at the driest time of the year. In wet weather they must always be unre- " liable.

" In rocky or very dry sites good earth connections are most difficult of attain- " ment. . . . .

" I do not think that tests made by weak currents are of any very great value " in deciding on the resistance of earth connections intended to carry off a great " charge of electricity at one instant of time, as in the case of a lightning discharge.

" H. SCHAW, Colonel, R.E.

"*24th January*, 1879.

" P.S.—Were all systems of lightning conductors arranged so that expansion and " contraction might be allowed for by S bands of flat iron instead of by slip joints, " and all other joints welded or soldered, electrical resistance tests could be applied " without difficulty, and I consider this would be very desirable.

" H. S."

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Admiral SIR WILLIAM KING HALL: Will you kindly tell me, bringing down a lightning conductor outside this building, how long the earth connection should be, what sized plate should you make, and in the case of an isolated country house with plenty of garden round it, a gravel soil, and with waste water pipes running into the ground, what should you recommend?

Major HAMILTON TOVEY, R.E.: I have had to superintend the arrangements for the protection of extensive buildings at Waltham Abbey, in connection with the powder works, and there naturally we had to be very careful. During the time I have been there, there have been four distinct cases in which buildings have been struck, and I had the opportunity of seeing them immediately afterwards. This circumstance, taken in connection with the situation in which Waltham Abbey lies, is a striking illustration of the truth of what Captain Bucknill says as to lightning being particularly liable to strike on damp soils, for, of course, four distinct cases within a short period and within a limited area is very far above the average. The first case was that of an entirely new building—a range of new mills for incorporating powder. The centre building was about 50 feet high, and on each side of it extended about 60 or 70 feet of lower buildings. There were lightning points over the centre and also at the extreme end of each wing. During a thunder storm, the point at the end of one of the wings was struck, but no damage was done, excepting that the stroke seemed to have a sort of shaking effect, loosening part of the iron roof trusses with which the conductor was connected, and shaking all the mortar out of some of the joints of the ironwork and brickwork. The stroke passed away without doing any other harm to the building. That is rather a striking illustration of how the lower part of a building can be struck when the high part is not, because the tower, which is considerably higher than the point struck, escaped.

The second case was rather a striking one. A small low wooden building, fitted with a copper conductor leading into water, was struck, although it was within 220 feet of a very high chimney—150 feet high—and was also surrounded by trees, a most unlikely place to be struck. The building was situated alongside a stream of considerable size, and the conductor led directly into the water. That, possibly, might have led to its being struck. There again the passage of the lightning had a shaking effect. The building was a low wooden one, and there was an arrangement by which a large copper basin full of water was balanced over the mill, so that in case of an explosion it would be upset over the powder, and this was shaken down. At the same time the lightning conductor was shaken away from the woodwork in places.

In another case the lightning struck a bell wire which was carried along upon several posts and was used for ringing a bell at the works. The lightning seemed to have struck a tree to which the wire was fastened, and then ran along the wire and passed down the posts. It was curious to see the way in which the electricity passed from one copper nail to another on the posts. After passing down the copper as far as it extended, it seemed to have jumped from one nail to the other, tearing the intervening wood out as it went.

The last case was not in the powder factory, but about one and a half miles off, in a private house, close to some works that we were executing—a row of villas. The chimney of one was struck. There was no lightning conductor, and the lightning passed down the chimney, probably attracted by the warm air from the fires, and then went from room to room down three floors, shaking the iron grates out of place, and in one case throwing it right out into the room, but fortunately no one was injured. That case showed how very difficult it is to know when you are near a flash of lightning, exactly how near you are, because a number of workmen were about the buildings, and although they must have been at least 100 yards away, they were terrified at the flash, and were all ready to swear that it struck the place they were in.

I should like to ask a question as to the Rio Tinto copper. I suppose if we went into the market to buy copper we should get commercial copper. Now, as it is almost impossible to tell where the copper originally comes from, I should like to know whether the Rio Tinto copper in the table on the wall is an ore or whether it is pure copper. It seems most extraordinary that there should be such a difference as 100 to 14 between two different sorts of unalloyed copper. The information Captain Bucknill gave us as regards the best way of forming an earth connection is exceedingly interesting, but it strikes me that authorities on electrical matters do not seem quite certain on this point about their ground. It certainly is rather alarming to hear that we ought to have 2,800,000 square feet of water surface connection, and I cannot help feeling rather comforted to know that in some buildings which I have put up that have been actually struck, a very much humbler connection has answered perfectly well. The system mentioned as the French system appears to be exactly the same as the old system in use by our own War Office, in which iron masts were placed in wells, and some of those are still standing. I am sure Captain Bucknill is entitled to our hearty thanks for his very interesting lecture.

Colonel SCHAW, R.E.: May I ask the last speaker one question with reference to the subject of earth connections? He mentioned that a low building was struck by lightning; it had a copper conductor on it, connected with water, which answered perfectly; could he tell us about what surface of the copper was in connection with the water, because it would be interesting to know that.

Major TOVEY: I could not tell you exactly, but I should say probably 5 or 6 feet of the conductor was actually in the water.[1]

Captain BUCKNILL: With reference to the question as to how the earth connections in this building (the Institution) should be made, I should recommend the use of the water main, and as there appears to be a garden at the back, a surface "earth" might with advantage be placed there along one of the paths. In reply to further questions concerning the "earths" to be used in a country residence, I cannot add much to what has been said in the lecture. The conductors should at all events be provided with an "earth" of the stated surface in contact with permanently moist earth, or with water.

Major Tovey's examples are very instructive, and prove that were equally intelligent observation general, we should soon know more about lightning than we do. It is impossible to make experiments on many important points connected with lightning, and the only way to gain sound knowledge on the subject is to examine the results of the strokes, as Major Tovey did. Too many of such records are full of frivolities, and omit the important matters. The shaking effect noticed by

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[1] The conductor was of copper band, $1\frac{1}{2}$ in. by $\frac{1}{8}$ in. in section; it was immersed for 3 feet of its length in water, the last 2 feet of the band being split up, forked apart, and covered with stones to keep it in place.

Major Tovey is, I think, due to the concussion of the air in the vicinity of the pointed rod. It will generally be noticed that the shaking effect is greatest at the top of a conductor, or chimney, or tree, which may be struck, and this would point to the conclusion that the damage is due to the concussive action of the lightning at the point where the disruptive path is changed for the conductive.

The case mentioned by Major Tovey of the lightning running along the bell wire and down several posts is instructive, for the wire does not seem to have been fuzed. The case much resembled one mentioned by Mr. Preece, in which telegraph wires were struck; the poles provided with leakage wires to the ground being unhurt, and those without leakage wires being torn and damaged.

In reply to Major Tovey's question concerning Rio Tinto copper (the figures on the Table B refer to the metal, not to the ore), I would repeat that all conductors should be specified not to exceed a certain maximum conductivity resistance per unit of length. Moreover, good contractors, such as Messrs. Newall and Co., Messrs. William Morton and Co., and others, will guarantee the conductivity of their copper ropes to be equal to that of from 80 to 90 per cent. pure copper.

Major Tovey misunderstood me as to the surface required for earth connections. My contention is that the earth connection is really a joint, that it should therefore follow the rule of other joints (viz., that its surface should be six times the efficient section of the inferior conductor, in this case $6 \times 2{\cdot}8$ millions of square feet) *unless we can show good reasons to the contrary*. In the lecture, reasons were advanced to show that such an "earth" is not only impracticable but unnecessary, and 6 times 4 the efficient section of coke, or 24 square feet, was fixed upon in order to save the coke from damage. If no coke intermediary were employed a surface of 6 square inches would appear to be sufficient to protect the iron from injury, but with so small an "earth" as 6 square inches, there would be great danger of alternative routes offering more facile paths to the lightning. This must be carefully guarded against, and as 20 to 30 square feet can be cheaply and readily obtained, it would appear undesirable to rest content with less when providing for the protection of magazines, powder mills, &c.

Colonel Baylis: I should like to ask a question, which may appear simple. When the lightning, as you say, bifurcates, or may be divided into several branches, does the force of the lightning weaken by its division? And then when the lightning is conducted into the earth and there distributed, we will say by the water pipes, is it diffused and lost altogether, or what becomes of it?

Captain Bucknill: When the lightning bifurcates an exact division of the energy is produced. In the case of lightning you must always remember that there are two opposing forces: there is the positive charge in the cloud and the negative charge below, or *vice versâ*, and the energy is produced between those two charges. The moment the flash takes place the up charge and the bottom charge unite and neutralize one another. The old idea of the current going away into the earth and disseminating everywhere is exploded. There are two equal and opposite currents, and they unite.

The Chairman: We have had a very interesting lecture, delivered by an Officer who is thoroughly conversant with his subject. I am sure it is very satisfactory to hear that our Government magazines are so well protected, and I think our hearty thanks are due to Captain Bucknill for his very interesting lecture.

# VISUAL SIGNALLING.[1]

By EDWARD J. C. RAMBUSCH (Premierlieutenant, Royal Danish Engineers).

*Introduction.*

ANY object, any movement, in short any thing, that confers upon our minds a conception different from the impression which its appearance calls forth to the senses, may be considered as a visual signal. Indeed, visual signals—the word taken in this sense—are far more frequently applied in every day life than they appear to be to such as do not examine the matter closely. Thus the letters of the alphabet may be considered as a kind of visual signals; they can confer upon one's mind a certain conception, beforehand agreed upon, that must be learned before it is understood. Every child knows the visual signal given by a raised forefinger, a nod with the head, a shaken fist, or many other signs in common use, although those signs in themselves signify nothing, and their meaning is to be learned before it is understood; yet many are these simple visual signals, that are known and made use of all over the world. You only need pass through any street (on the Continent) to find a great number of visual signals applied as sign-boards by the different manufacturers or dealers in various articles viz., a boot, a pair of brass dishes, a piece of iron plate (meant to represent a piece of leather), &c. Although supplied with electric telegraphs, the railways always make use of visual signals as means of correspondence between the arriving or passing train and the stations or gatekeepers. The lanterns of a ship, the funnel-marks of steamers, &c., are so many visual signals, nay, even the flags, colours, and standards of the different nations, are visual signals, giving a certain amount of information regarding those who bear them.

Each of the signals, hitherto named, can convey but one single piece of information; every new communication that is to be sent requires a signal more, and very soon the number of signals will be too great to admit of a person remembering them all. A code, containing the meaning of all used signals, is composed, by means of which it is possible after a little practice to find out the meaning of any sign to be found in the code, or to dispatch any of the code's communications. A signal system of this kind, a "Code System," is inseparably bound to the code: the messages of the code may be forwarded quickly, but

[1] This treatise is somewhat altered from a paper read by the author in the Danish "Krigsvidenskabeligt Selskab" (Society for Military Science).

it is quite impossible to communicate anything that is not to be found in it, and when the code is not at hand, the system cannot be applied.

Whenever a code system has been developed to a certain degree of perfection, the number of messages becomes so great, that it is much too troublesome to have a special sign for each of them. We therefore take a few different signs or indications, which we can easily make, and we join them together in twos, or threes, or more at a time, making one after the other, into many and different and more complex signs or arrangements. Each of the original signs are called single, or primary, or elementary signals. The new signs made by joining these elementary signs together are called the combinations or combination signals. This already is the way to the other chief group of signal systems, the alphabetical; as, indeed, a similar proceeding is followed when we combine into words, the letters of a common alphabet. In an alphabetical system, the alphabet is often called "the code" of the system, but it differs essentially from the above named codes, in being so short and numbering so few characters, that it is easily learned by heart, and yet it permits any word of the language being expressed.

If visual signals are to acquire the same ability as the common written language to express whatever idea, whatever thought, presents itself to the mind, it is necessary to form them upon a common alphabet. The simplest thing would be to have an elementary signal for every letter of the alphabet, but as this would require a rather cumbersome apparatus, it is more common to apply fewer elementary signals, forming the letters as combinations. In fact a single elementary signal might be sufficient, the number of times it was repeated indicating the combinations; but this way of signalling would be tediously slow. It is more practical to apply two, three, four, or five elementary signals; most common is the use of two elementary signals, the combinations of which are formed upon the Morse alphabet.

Hitherto it has not been mentioned how the elementary signal itself is formed, as this is quite indifferent for the formation of the system. Any thing in existence, to which we can direct the attention of others, may be used as a signal. It may be a certain object, shown in whatever position, or it may be a certain position, as, for instance, the horizontal or vertical position of a spontaneous object, or it may be a certain movement of any object, &c., or several of these things may be combined, so that any position or movement assumes a different meaning as to the object that is used.

Considering the extensive use of visual signals in every day life, it might appear rather strange if they were not useful in armies. In fact every soldier learns certain signals, by which to communicate such tidings as most frequently occur, when on outpost, for instance: "Something suspicious," "Enemy in view," &c.; here we have a kind of code system, but a very imperfect one, and only fit for short distances. But the question is, whether a more developed system, fit for long ranges and requiring special means and drilled men, is sufficiently useful to armies to justify the incurring of considerable expense. And as the testimony of experience is the very best one, the

best judgment will be gained by considering to what extent visual signals have been employed and developed in the course of time, and what services they have rendered where employed.

*Historical Review.*

The use of visual signals of a primitive kind, especially of beacons and prognostics, can be traced up to the most ancient times. Thus the Tower of Babel was a kind of visual signal, destined to serve as a mark or rallying point for the surrounding population. A beacon, however, is a very imperfect signal; it only can convey one tiding: "To arms! the foe is coming!" but can tell nothing about who, or how strong the enemy is, on what point he is attacking, or where the muster-place is to be. Therefore the tidings of the lighted beacons were to be completed by a messenger, carrying further orders. The way in which these messengers were sent forward by the Scottish Highlanders and the ancient Scandinavians was thus (Walter Scott): "When a chieftain designed to summon his clan upon any sudden or " important emergency, he slew a goat, and making a cross of any light " wood, seared its extremities in the fire and extinguished them in the " blood of the animal. This was called the Fiery Cross, also Crean " Tarigh, or the Cross of Shame, because disobedience to what the " symbol implied inferred infamy. It was delivered to a swift and " trusty messenger, who ran full speed with it to the next hamlet, " where he presented it to the principal person, with a single word, " implying the place of rendezvous. He who received the symbol, was " bound to send it forwards with equal dispatch to the next village; and " thus it passed with incredible celerity through all the district. . . " At sight of the Fiery Cross, every man from sixteen years old to " sixty, capable of bearing arms, was obliged instantly to repair, in his " best arms and accoutrements, to the place of rendezvous. He who " failed to appear suffered the extremities of fire and sword, which were " emblematically denounced to the disobedient by the bloody and burned " marks upon this warlike signal." During the civil war of 1745–46, the Fiery Cross often made its circuit; and upon one occasion it passed through the whole district of Breadalbane, a tract of thirty-two miles, in three hours.

Yet even this speed was not sufficient, the messenger was to be dispensed with; in other terms, the visual signal was to carry the entire message itself. It was no difficult invention to employ a greater number of visual signals, instead of one, the beacon; it was easy to add new signals whenever a new thing was to be communicated, and in this way complete code systems were soon formed. King Perseus had already communicated through whole signal lines with the most remote parts of his kingdom. During the Trojan war, the civilized nations knew, and made use of, more or less perfect signal systems. Thus the conquest of Troy was signalled to Argos, over a distance of 330 miles, and all over the Ægean Sea. When, in 479 B.C., Mardonius had taken Athens, he sent this news by fire signals, from one isle to another, over the sea to Xerxes, at Sardes. What kind of systems

these were, is unknown, but in the sea-battles of Cycicus and Mytilene the Greeks performed the decisive manœuvres upon orders communicated by an alphabetical signal system, an invention of Cleoxenes and Democritus. After this time, visual signals were frequently made use of in Greek and Roman wars, and they had special signal-troops, whose name, *πυρευται*, *i.e.*, fire-bearers or fire-shakers, indicates a signalling at night, and most probably by means of certain movements, perhaps similar to the swinging of the torches formerly used here. We owe the oldest of systems at present known to the Roman commander and author Polybius, who states that he had formed it by an improvement upon the systems of Cleoxenes and Democritus, and who used it during the first Punic war. The apparatus consisted of two groups of torches placed at a little distance from each other, and concealed behind a fence or screen. The Greek alphabet, arranged in five columns in the following way, was used as the code. The smaller letters are to show the English alphabet arranged after the same method:—

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | Α *a* | Ζ *f* | Λ *k* | Π *p* | Φ *uv* |
| 2 | Β *b* | Η *g* | Μ *l* | Ρ *q* | Χ *w* |
| 3 | Γ *c* | Θ *h* | Ν *m* | Σ *r* | Ψ *x* |
| 4 | Δ *d* | Ι *i* | Ξ *n* | Τ *s* | Ω *y* |
| 5 | Ε *e* | Κ *j* | Ο *o* | Υ *t* | Z |

Now to indicate the column where any letter is to be found, one or more torches are raised over the screen, in the one group, the number of the torches shown indicating the number of the column; at the same time torches of the other group are raised over the screen, indicating by their number the place of the letter in the indicated column. So to indicate in the third column, the second letter, "third, "second" is written, or there are shown three torches of the first group, and two of the second.

The Carthaginians also employed visual signals, and by this means kept up a communication with Sicily. It is related in the history of the siege of Agrigentum, that, although the town was perfectly invested, the commanding officer was signalling its condition over

the heads of the enemies, "by shaking (or 'swinging') through with "fire" (διαπυρσευομενον).

During the middle ages visual signalling, like most of the civilization of the Ancients, was forgotten, yet it seems probable that a knowledge of it has been preserved in the East. The first time that it is again known to have been employed by European armies was during the siege of Vienna, in 1683, when John Sobiesky had marched to the rescue, and a certain John Smith in his army from the Kahlenberg opened communication with the besieged town over the heads of the Turks. Although there were several other causes, it is very probable that the defeat of the Infidels was partly owing to the co-operation of the besieged garrison and the relieving army, ensured by the signals of John Smith.

Visual signalling was not commonly employed until the year 1789, when the French engineer, Claude Chappe, invented his apparatus. On the top of a semaphore was suspended a long beam, with a shorter wing at each extremity. The different parts could be placed so as to form different angles between the wings and the beam, as well as between the beam and the semaphore. By a combination of the different situations of the various pieces, 196 figures could be formed, the meanings of which were to be found in a code. A telegraph of this kind was soon erected between Paris and Lille, about 130 miles. It made, as it were, its entry into history, by bringing to the convent the good news of the recapture of Condé from the Austrians, the same forenoon the town had surrendered. This form of telegraph was much used by Napoleon, who had many lines established, and it worked remarkably well; to such a degree indeed, that it was possible to forward a single signal from Lille to Paris within two minutes, and a short message from Berlin to the Rhine (480 miles) within fifteen minutes. A telegraphic apparatus, of somewhat different construction, was introduced into England, by Sir George Murray, a few years afterwards. A greater or lesser number of large wooden tables might be hoisted on a kind of scaffolding or system of frames. The number and situation of tables exhibited indicated the meaning of the signal which was to be found in a code. A telegraph of this kind was established between London and Plymouth, where it rendered valuables services during the great wars against France. The same telegraph was introduced in Denmark, in the beginning of this century, and a line was erected over the Great Belt, where the passing is in winter extremely difficult, and where it was of great value, until it was replaced by the electric telegraph.

The above telegraphs, however, were only fit for permanent stations, and all essays in making them sufficiently movable for field use did not produce the desired effect. Naval Officers, however, took these inventions in hand and improved and developed them, until a great degree of perfection was attained. The code of Sir Home Popham marks a grand progress. He represented each message by an arrangement of numerals, which might be sent to other ships by means of some twenty flags and pennants of different forms and colours, each representing a certain number. At night, coloured

lanterns were used instead of flags and pennants. Should the case occur that the message to be sent was not to be found in the code, it was possible by an agreed signal to indicate that spelling was to be used, and then to send any word, one letter after the other. Thus the system was to combine the advantages of the alphabetical systems with those of the code systems. This system was first introduced into Nelson's fleet just before the battle of Trafalgar, and made its *début* in communicating to the fleet the celebrated proclamation: "England "expects that every man this day will do his duty." The superiority of this system over those formerly used soon caused its being adopted amongst all civilized navies, and somewhat later an English and French Commission composed an international code that by-and-bye came into use on board most large merchantmen. As it is not bound to any language, it enables the crews of any two ships to communicate with each other without understanding a word of each other's language. The honour of this meritorious work is principally due to the Englishman, Mr. Larkins, and the French Lieutenant M. Sallandrouze de Lamornais. But all these systems were too cumbersome for field-service, requiring a large apparatus and especially a high pole that could not always be at hand or easily and quickly raised; and it was only on board ship that they continued in use after the electric telegraph had banished all visual signalling from the Continent. Yet it was by-and-bye discovered in the armies, that even the electric telegraph has its deficiencies and its limits and cannot satisfy all wishes, and that it fails just in such cases where a good signal system would be of use. Several attempts were made to devise a good one, fit for use in the field. A French Count, Pouget, "*Capitaine de frégate en retraite*," lays claim to having invented a practical system by a simplification of that used in the navies, and by diminishing the number and size of the flags so that a horseman could not only carry the whole apparatus with him on horseback, but could even exhibit the signals while in motion. This appears very tempting, but as Captain Pouget keeps secret all further details, such as the way the flags are displayed, the ranges at which they can be seen, the rate at which the signalling is carried on, &c., it is impossible to form any trustworthy opinion as to its usefulness when compared with other systems. Yet it ought to be observed that signalling, being carried on while the signallers move, the signals are to be read with the naked eye—therefore on short ranges—and that the system, being a code system, is less perfect than an alphabetical one. As far as I have been able to ascertain, this system has not been practically employed in any army.

It was the American Colonel (afterwards General) A. J. Myer, who was the inventor of veritable Field-Signalling. He devised several alphabetical systems formed of a various number of elementary signals, but seems ultimately to have preferred one with but two elementary signals as most fit for field use. Colonel Myer made great use of his signals during the war between the United States and Mexico, as well as in several Indian campaigns, and they were, during the great civil war between the Federals and Confederates, employed upon an extensive

scale. But Colonel Myer no longer had the advantage over the enemy in alone employing visual signals, for, unfortunately for him and his party, one of his former subalterns, having learned his system, joined the Confederates and introduced it in their armies, so that both contending parties vied with each other in deriving the greatest possible advantage from their visual signals.

The signal staff, of hickory, was made in four pieces, each 4 feet long, and tapering as a whole from $1\frac{1}{4}$ in. at the butt to $\frac{1}{2}$ in. at the tip. The joints were ferruled at the ends with brass, and fitted to be jointed together. When in use two or more joints of the staff were fitted together.

The signal flags were made of some light and close fabric, and used of three different sizes, viz.: 6, 4, or 2 feet square. They were either black or red, having in the centre a block or square of white, or they were white, having in the centre a block of red. The breadth of the block was one-third of that of the flag. At night torches were used, one, the flying torch, to fix on to the signal staff, another, the foot torch, to place on the ground, as, without a fixed point in view, it cannot be distinctly traced to which side the flying torch is moving. The torches were copper cylinders, filled with turpentine, petroleum, or other burning fluid, and furnished with a wick of cotton.

The signals were observed and read with the aid of a binocular field-glass or telescope. When signalling was to begin, the flagman raised the flag or torch directly above the head. The motions "one" or "two" were performed by waving the flag directly to the right or left side until it touched the ground and bringing it at once back to the first position. The "one" and "two" of the visual signals were to represent respectively the dot and dash of the Morse alphabet, so that any telegrapher might be employed at signalling nearly without any special training. The different motions belonging to the same letter were performed without stopping, for instance, d=211 by a wave of the flag to the left, thence, without stopping in the vertical position, immediately over to the right, thence to the vertical position, thereupon at once down to the right again and thence back to the vertical position, where it was to stop a moment before beginning a following letter.

These signals were generally used at 10 or 12 miles' distance; communication is said to have been had at 25 miles, and detached words are reported to have been read at 40 miles' distance. The following examples will give an idea of the results attained during the Civil War.

In 1863 the Federal army under Hooker passed the Upper Rappahannock, intending to attack Lee's left while a corps of 40,000, under Sedgwick, passed the lower river at Fredericksburgh. But Lee guessed their intention, threw himself between the two parts of the northern army, defeated Hooker at Chancellorsville, and turned upon Sedgwick, who was in great danger of being cut off from his bridges. But he was saved by his signal communication with the troops on the northern bank from which a telegraph led to the head-quarters of Hooker. Being informed of Sedgwick's dangerous position, Hooker, by a renewed attack, procured him the time to repass the river.

During Porter's attack of Fort Fisher in 1864, the landed force observed the effect of the firing from the fleet and, by communicating through signals the result of their observations, enabled such precision of the fire, that most pieces of the fort were soon silenced, and the crew could scarcely stir from out of the casemates. This was the chief cause of the easy success of an attack, that a short time before had been so completely beaten off.

When, in 1864, Sherman had occupied Atlanta, Hood, by a quick manœuvre, tried to cut him off from his lines of supply and attack his base at Allatoona. Hood was already so near Allatoona, that it would have been impossible for Sherman to come to its assistance in time, had not the chief of his signal corps, Captain Bachtal, succeeded in approaching sufficiently near to the 50 miles distant Rome, to order General Corse to the assistance of Allatoona. Corse, with a brigade, reached Allatoona in due time, but a mishap with an engine stopped the rest of his troops, and soon the whole army of Hood made its appearance. The first attack was happily beaten off, but still the danger of being overpowered was imminent, when suddenly something was seen to move on Mount Kenesaw, at 18 miles' distance. It proved to be the signallers of Sherman's army, and the news of the approaching assistance highly elevated the courage of the defenders: the reply sent by Corse, that he held his own, and would continue to do so, was not less welcome to Sherman. He had marched to the rescue with all possible speed, and in front of his army, with the foremost cavalry patrols, signallers hurried on from mountain-top to mountain-top waving from each of them their flags, until communication was established. Hood was obliged to beat a hasty retreat into the Alleghany Mountains.

At a later period, when Sherman, having finished his grand march through Georgia and Carolina, gained Savannah, near the Atlantic, his signal corps had communication with the Federal fleet on the same day that the army had carried the fort McAlister, and thus gained a firm footing at the sea-coast.

General Gillmore had, during the siege of Charleston, by means of a signal line of 55 miles with seven stations, established communication from his head-quarters to the different army corps as well as to the fleet. As the country was woodland and difficult to overlook, it was necessary to erect some signal stations on high scaffoldings, some of which attained a height of 138 (after other reports 160) feet by 30 feet square base. This signal line rendered valuable services, although it was a terrain where a part of it ought rather to have been furnished by the field telegraph.

General Early, during the winter 1864–65, lay in Staunton, and had against him Sheridan, at Winchester. But Early had left before Newmarket cavalry detachments, with which he maintained telegraphic communication, and which had, by advanced patrols, established signal stations in Ashly's Gap, on the northern side of the Massanutten Mountains, and even in the lower Shenandoah valley in the enemy's rear, so that they overlooked his camp with all its environs. By this means Early at once was informed of any operation against him

by Sheridan, though they were at 90 miles' distance from each other.

Visual signals were not much employed in the wars of 1866 and 1870; they were, however, used at the sieges of Belfort and Metz, where the available field telegraph *matériel* was not sufficient. Neither do they seem to have played any pre-eminent part during the Russo-Turkish War, though many a time the contending armies had to feel bitterly the want of such a means of communication. It is only necessary to call to mind the battles in the Shipka Pass, as well as the first rencontre at Plevna, which would probably have taken another turn, had it been possible sooner to have called to aid the supporting forces; whereas the Russians took great advantage of their field telegraph in the campaign against Moukhtar Pacha, though the communication with the turning column through a field telegraph line must needs have been in great danger of interruption, and a signal line here would have been less endangered.

The Austrians, during the late campaign in Bosnia, made use of visual signals to a great extent, and, indeed, without them, would not have been able to keep up the needful unity of operations.

The system employed was the "clock-vane system" of Lieutenant-Colonel Yonge, of the English army, which is also used in Italy. It consists (such as used in Austria) of a pole, 6 feet in height, at the top of which is a triangular wing of 5 feet in height with a base of 3 feet, a smaller triangle being cut out of it in the middle. It can be shown in twelve different positions, which number is redoubled by hoisting a "point" over the triangle or omitting it. The "point" is a circular disc of 2 feet diameter, a smaller circle being cut out of its middle. The twenty-four signs represent the twenty-four letters to which the alphabet may be reduced.

According to the accounts of Austrian Officers, signalling was carried on at distances of 8 or 9 miles; but here it ought to be observed, that they possessed telescopes of very superior quality, and that the air of the southern climate and those rocky heights is much more transparent than in our hazy country. The conclusion therefore is, that, under equal circumstances, this system can hardly be used at so long distances as the flag system. Indeed, it would appear very strange if the above described triangle and disc, being much smaller, should be more visible at any long distance than a 4 feet square flag, which is waved, moreover, as it is generally acknowledged that—

> "Things in motion sooner catch the eye,
> "Than what not stirs."
>
> SHAKESPEARE.

As to the rate at which signalling can be carried on, I have not been able to find the desired data, but it seems scarcely credible that, under ordinary circumstances, each letter might be shown by the one station, recorded and repeated by the other, and changed in much shorter time than four or five seconds, which should be the case if the quickness of this system was to prevail over that of the dot and dash system, with 4 feet flags. The clock-vane system, it is true, may be

somewhat easier to learn, and especially to remember, by such as do *not* use it every day, but it is more difficult to extemporize the *matériel*, and it is less fit for use on intermediate stations, being less able to change the front. It appears certain that the clock-vane system is a very ingenious and useful signal system, but scarcely superior to the dot and dash system with flags; yet it is impossible to judge with full certainty of the matter without having tried both systems under equal circumstances, and assisted by equally trained men.

During the last few years the English above all others have developed and made use of visual signals. A small flag has been introduced for short distances, and by it messages are said to be sent at a minimum rate of ten words per minute. This flag gives the advantage over signalling to mounted orderlies, even at short distances. But a still greater improvement is the invention of the heliograph. As it was exhibited and explained at the Royal United Service Institution last year by Major Wynne,[1] I shall not here enter into any details as to its construction. This wonderful instrument has often sent its messages to distances of 25, 30, or 35 miles; it has been tried to ranges of 50 miles without telescopes, and one memorandum even states that signals with a 6 or 8-inch mirror have been seen with the naked eye at a distance of 100 miles. At night the instrument has been employed as a "selinagraph" (using the moon's rays), and the signals were discerned with the naked eye at 12 miles distance; at short ranges even the light of a planet has been used; but it must be remembered, that all the above-mentioned feats were performed in southern and sunny countries.

The immense services rendered by the heliograph during the campaigns in Afghanistan and Zululand are certainly so fresh in the memories of the readers, that it is useless to repeat the circumstances of the different cases. Few who have heard or read the account of Major Wynne will deny that the heliograph has been of inestimable value to the British cause and has saved thousands of brave soldiers from disaster.

It would be easy to name, besides so many instances of valuable services rendered by signals, a still greater number of cases where the want of a similar means of communication has been most bitterly felt. Thus the defeat of the insurgents in the Battle of Idsted would certainly have led to the capture or destruction of their whole force if the Danish Brigade Schepelern, who had completely turned them, had been in signal-communication with the Commander-in-Chief. The defeat of the French at Waterloo would, on the contrary, scarcely have been so complete had Napoleon, by a signal-communication with Grouchy, been informed in time of the fact that this General had been outwitted by Blucher, and that it was the latter, not the former, who was arriving on the battle-field in the afternoon. Indeed, there is hardly an Officer who has seen service who cannot call to mind scores of instances in which it might have contributed to the success of an expedition or engagement, if he and his fellow Officers had only possessed so much skill in signalling as may be acquired by a few hours' practice.

[1] See Journal, vol. XXIV, page 335, *et seq.*—ED.

## *Development of Signalling in Denmark.*[1]

During the wars of 1848–50 and 1864, especially during the first, signal lines were erected and were of use, but the systems applied were only fit for stationary lines; it was no real field signal service. In 1868, the "First Battalion of Engineers" caused a *matériel* to be extemporized, and with this, during the ordinary camp, in the same summer, the dot and dash system was tried with flags and torches. As the trial had a satisfactory result, the *matériel* was by-and-bye completed and formed of flags, petroleum torches, and flashing lanterns (Blinklanterne). As for the flags, only two patterns were used, one red with a white block, another white with a red block, both of 4 feet square in size. It was considered useless to have larger flags, as the 4 feet flag is quite sufficient at the distances that our climate permits. Experience has shown that, on light backgrounds, the red-white flag shows more clearly than a black-white one, so no black flags were procured; but it is probable that, for use on short ranges, 2 feet or $1\frac{1}{2}$ feet flags ought to have been procured besides the 4 feet ones. The torches were principally used as in America, being waved as the flags; they were sometimes also placed on the ground and alternately obscured and exposed so as to mark the dots and dashes by flashes. But we were not satisfied with them, as they did not burn sufficiently constantly, and were too much influenced by the wind. The lantern was a lens-lantern with an oil lamp in it, and a screen to hide the light. By lifting the screen, short or longer flashes, representing the dots and dashes of the Morse alphabet, were produced. The lifting of the screen is operated by means of a small handle, similar to the Morse key, but takes so much time that even the dot is of some length, and as the length of the dash ought to be the triple of the dot, signalling becomes too slow for the short distances—one or two miles—at which the lantern can be used. Therefore it has found but very little application, though it is still forming a part of the equipment. For observation, telescopes, on tripod stands, were used, and for scanning the surrounding country, each station was supplied with binocular field-glasses.

Upon the whole, the day signals were found to work satisfactorily, only their use was improved by practice, as were also several parts of the Manual of Instruction. Thus, instead of using three pieces of the rod (which is much like the above described American one), the flag is now almost always used with two pieces only, and this 8 feet rod has been sufficiently evident even at ranges of 4 or 6 miles. Any signaller, and, indeed, any one knowing the laws of a pendulum's movements, will understand that signalling can be carried on at a much quicker rate—in fact the double—with an 8 feet rod than with one of 12 feet. The rules for signalling are now, in short, as follows: Whenever a word is finished, the flag man at the sending station twice elevates his flag as

[1] Though the following was written especially with reference to Denmark, it has not been thought right to omit it here, as it, in the present somewhat shortened and altered form, might be of interest in any country with an insular climate like our own, by the adduced data from our practice in signalling.

high as possible, each time immediately lowering it again to the normal position. Each word is to be acknowledged by the receiving station by "understood" (the flag is lowered to the ground in the direction of the sending station, and at once raised again) or by "not "understood" (six "ones"). Formerly the whole message was sent before any reply ensued, but, in case of misunderstandings, the new method saves much time and trouble. If intermediate stations are employed, they send on the message, letter by letter, as soon as each letter is received, to the receiving station, from which the "under-"stood," or "not understood," after each word is repeated by all intermediate stations until it arrives at the sending station. Any word replied to by "not understood" is of course to be at once repeated by the sending station.

In case a message should be observed by an enemy, a part of it can be sent in cipher. For enciphering a message, Wheatstone's Cryptograph is used. It is a cipher wheel, in appearance similar to that shown in the (English) "Manual of Instruction in Army Signalling," consisting of an outer and an inner circle with letters. Round the outer circle the twenty-six letters of the alphabet are placed in usual order, and one place is empty, the circle containing twenty-seven places. The inner circle contains only twenty-six places in which the letters of the alphabet are placed in any spontaneous order, different from the usual one. An arm, reaching to the outer circle, and a vane, reaching to the inner one, are fastened to a pivot in the centre. The arm wears a cog-wheel with twenty-seven cogs, and the vane another cog-wheel, having only twenty-six cogs. Both cog-wheels work in the cogs of a third cog-wheel, placed near them on an independent axle. If now the arm is moved on from one letter to another, its cog-wheel following the movement is turned so much round as the breadth of one cog, it moves the loose cog-wheel, and this again moves the cog-wheel of the vane just as much, viz., the breadth of one cog, and this, being firmly combined with the vane, moves it on from one letter to the following. When the arm has made a complete revolution, any point of the disc, near the circumference of the cog-wheel, has been passed by 27 cogs, consequently the cog-wheel of the vane has also been turned as much as 27 cogs, but its circumference only has 26 cogs, so it has turned quite round, and one cog more, which is to say, that the vane itself has made a complete revolution, and has still passed on one letter further. Suppose the arm points to the empty place, and the vane to any letter, for instance, *d*. If the arm is moved once round and points again to the empty place, the vane does not point to *d*, but to the letter succeeding *d* in the inner circle. So, whenever the same letter is repeated in the original message, it will be represented by a different letter in the cipher message, which renders the deciphering of some intercepted message very difficult, while at the same time the use of the cryptograph is so easy that, without any difficulty, all privates of the telegraph company are taught how to employ it.

Now, to encipher a message, put the arm on the empty place and the vane on the "key letter," beforehand agreed upon; move on the

*arm* to the first letter of the message, look where the *vane* is pointing and write down that letter, move on the arm to the second letter of the message, and write down the letter at which the vane is now pointing, &c. The deciphering of a message through the cryptograph is just as easy. Place the arm at the empty place, and the vane at the key-letter; move on the arm till the *vane* points at the first letter of the received cipher message and write down the letter at which the arm is then, &c.

Sometimes a message has been enciphered at the sending station by one man, whilst it was sent off by another, and at the receiving station it was deciphered as quickly as received, without any loss of time; but ordinarily a little time has to be spent in enciphering and deciphering. Cipher messages are always repeated by the receiving station, and some other detailed rules are given for the practice with the cryptograph.

As the night signals were not satisfactory, several other means of night signalling were tried.

The Chatham light is a very brillant one, produced by combustion of the "Chatham powder," a mixture of magnesium, resin, and lycopodium in different proportions, according to the power of light required. By means of a pair of bellows, a sharp current of air is produced, and it blows a jet of the powder into the flame of a spirit-lamp, where it becomes ignited, and produces a flash, lasting till the current of air stops. But the burned powder does not entirely disappear, the remains partly fall down to the bottom of the lamp and partly cleave to the glass, so that it becomes less transparent when the lamp has been worked for some time, which renders the light less brilliant, and causes some difficulty in discerning the length of the flashes. On account of these causes the lamp was not entered into our equipment.

Walker's Lime-Light Lamp was then tried. Here a lime pencil is heated in the flame of a spirit-lamp, reinforced by a current of oxygen. The lime becomes white-hot and gives a very brilliant light. The flashes are produced by elevating and lowering a screen. The lamp was deemed fit for permanent stations, and the adoption of it for those was proposed to Government; but for field signalling it was not recommended, out of fear that the producing and transport of oxygen in the field might cause some difficulty, and that the gas-bags might not be able to stand being exposed to the change of weather and ill-use, inseparable from field service.

At last, in 1877, we succeeded in finding a means of night-signalling, that was deemed tolerably satisfactory for use in the field. It was Spakowsky's flashing lantern,[1] which had already at that time been introduced into our navy for use for signalling with stations on shore. After having been repeatedly tried, and after having received several improvements, this lantern was adopted by the Telegraph Company. A small spirit-lamp, invisible from without, is constantly burning in the lantern, when in use. By means of a pair of bellows and an apparatus similar to the well-known flower syringes (*rafraî-*

[1] *See* Journal, vol. xi, No. XLVII, page 658, *et seq.*

*cheurs*), a steam or drizzle of petroleum can be blown into the spirit-flame, where it is ignited, and burns with a brilliant blaze, 1 or $1\frac{1}{2}$ ft. high, until the current of air from the bellows ceases. The length of the flash is regulated by the mechanism of the apparatus, so that a dash is equivalent to three dots. The signals of this lamp have been read with the naked eye at a distance of 14 miles, and at a distance of 4 miles the lantern has been employed with great success during a rather heavy rain. On shore the lantern is placed on a tripod stand; on board ship it is usually fastened to a pole, supported by a man.

The *matériel* belonging to a signal station was originally taken along on an ordinary waggon; but as it suffered much by the transport on rough roads or over fields, and by being loaded or unloaded so very often, a box for this use was constructed, in which every object was either put into a special compartment, where it fitted closely, or strapped tightly to the proper place in the box. These boxes, however, being very large, heavy, and cumbersome, a signal-station carriage of a peculiar pattern, very light and singularly fit for passing obstacles and accidental terrain, was constructed in 1876. After having been tried several times, and after having received several improvements, it was adopted as the normal carriage for a signal station. It consists of two parts, limbered together in a fashion similar to that employed with field-guns. Each half-carriage is fitted with a box like the above-mentioned, some 4 ft. long, 2 ft. broad and high, containing *matériel* for a single, or terminal station, the double of which is adopted as normal for a complete, or intermediate station. This way of dividing the *matériel* has the advantage that, in cases where great ease and mobility is required for a terminal station, for instance, if it is to follow a cavalry raid, the fore-carriage alone may be used. On each box are seats for three men, and behind the seats there are hooks and straps for the fastening of kits and carbines. The carriage is drawn by two horses. The Officers and the elder non-commissioned officers are mounted.

This complete development of the signal service has been brought out by the Telegraph Company (Royal Engineers), originally destined only for the field telegraph service of the army. Thus the creation of a signal company, or of an extra telegraph and signal company, is much wanted; it has long been desired, and was last year by the Government proposed to the Parliament, which latter, however, refused to vote the necessary expenses.

There is another fact that has often been an obstacle to signalling practice, viz., the want of horses, for the Engineer Corps has no horses of its own, but is directed to apply for them to the artillery, when wanted. This occasions that every practice in signalling or telegraph service is to be pre-arranged several days before it is to take place, which is a serious inconvenience.

### *Observations on the use of Visual Signals.*

If a visual signal corps is to fulfil its duty completely, it is necessary not only that the corps itself is sufficiently able and well-drilled, but also that the commander, at whose disposal it is placed, is perfectly

acquainted with its abilities, its advantages and disadvantages, so that he knows how to employ it.

As to the signal corps, every man ought to be fully trained in sending messages with flags and the other means in use, in managing and using the telescopes, enciphering and deciphering messages by means of the cryptograph, and, last, but not least, he must know the signal alphabet by heart, just as well as the common letters. Whoever can be entrusted with leading a signal station, ought to possess the same accomplishments, and, moreover, must be able to find his position quickly, even in an unknown and difficult country; he must have a good apprehension of the terrain and the ability to find out without much loss of time where other stations are placed. These qualities are far more difficult to acquire than most people suppose; much experience and practice in the field is necessary. A signaller ought to be a perfect soldier, vigorous and able to suffer hardships, but of all bodily accomplishments, none is more needful than a keen and long sight, without which no man should ever be appointed to signal service.

Yet even with the best-drilled and most skilful troop, much loss of time may be caused by the laziness, ill-will, or negligence of a single man, and often it may be extremely difficult to point out who is the guilty one if faults are committed or delays occasioned; indeed, much depends on the good will and zeal of every private, therefore the *morale* of the troop ought to be of the very best; it must be brought to such a point, that each man puts his honour into the performance of his duties with the utmost possible celerity and accuracy. An Officer who does not understand how to inspire into the minds of his subalterns the highest degree of emulation and self-devotion, may be very able to command other troops, where obedience can be enforced, but should never be employed in signal-service.

As to the other point, the acquaintance of the superior commanders with the signal service, it has been but too often disregarded. If a signal corps is placed at the disposal of a superior Officer, unacquainted with its use, he will exact either too much or too little of it; in the first case the signal corps will not be able to satisfy his expectations; in the second, it might do more, but will have no opportunity fully to display its usefulness; in either case the commander concerned will form a false opinion of the signals, without observing that, by his own fault, the signal corps was not used as it ought to be. At other times you will see a communication by visual signals employed, where a field telegraph line would better do, or *vice versâ*. But while literature is so destitute of directions and practical hints as to the use of visual signals as is now the case, such knowledge as is required can only be obtained by personal experience and practice in the application of this new apparatus.

A signal station must be situated near the commander at whose disposal it is placed if it is to be of the greatest possible advantage to him. As its place cannot be chosen spontaneously, but depends on the terrain, the commander will often be obliged to have regard to this, in choosing his own place, which may be a little inconvenient,

as there are many other views to be considered; yet it is an advantage, that signal stations are nearly always erected at good look-out points.

He who wants to employ visual signals to the greatest advantage ought to pay attention to two things principally: the distance at which signalling can be seen, and the rate at which it can be carried on.

The distance depends upon the transparency of the air, the skill and practice of the signallers, and the apparatuses employed.

It is a matter of course, that all visual signalling is rendered impossible by a dense fog, a heavy rain, or thick snow. That is the chief disadvantage of visual signalling, and is always adduced by the antagonists of the service as a proof of its uselessness. But have not the visual signals of navies, or even its lighthouses, the same shortcomings, since they are invisible when the sailors stand most in need of their guidance? And yet nobody thinks of abolishing them; they are, on the contrary, constantly improved, and their number is augmented. In fact, however, this disadvantage of visual signalling, though great, is by no means so decisive as it might appear at first sight. In the first place, it must be remembered that the other means of communication are also dependent upon the state of the weather; the same weather that is an obstacle to visual signalling causes great difficulties to the orderlies finding their way, and even the electric telegraph may be destroyed by storms, or rendered useless by thunder. In the second place, the said inconvenience is partly extenuated by the fact, that he who is to make use of the communication by signals always may know beforehand when it is useless, or in any case may be very soon informed whether his message will reach its destination or not; whereas he will be uncertain whether a detached orderly has fulfilled his task until the orderly has returned again. In the third place, it ought to be well observed, that a complete interruption of signalling, even in our climate, does by no means take place so often as is commonly supposed; but whether the state of the atmosphere is to be considered transparent or not depends in an astonishing degree on the signallers' skill and ability. When, in a semi-transparent atmosphere, a man without practice sees the flag so indistinctly that it disappears out of his sight every other moment, and renders the observation of its movements quite impossible for him, an able and practised signaller will read message after message without failing; and practice is of still greater importance for night signalling, when the length of the flashes are to be judged. Any signalling officer with some experience in the matter of instruction can testify to what an astonishing degree the difficulties caused by a thick atmosphere are diminished by-and-bye, as the practice and skill of the signallers increase. Signalling at 4 or 5 miles distance has often, without any serious difficulty, been carried on through an ordinary rain. Last autumn we signalled for two hours without any interruption between Lyngby and Thinghöj, a little more than 4 miles, though it rained so hard that we were all wet to the skin, and some had their top-boots full of water before we stopped. During the camp last summer, signalling was practised twenty times, thirteen times out of which it was continued a part of the night, and

a few times all night long, till the following forenoon. Out of these twenty signallings, one, a single one, was completely interrupted for several hours by a fog, and another for a quarter of an hour by the morning haze, and the smoke of gunpowder. Four times there fell some rain during the practice, without influencing it in any considerable degree. The distance between two neighbouring stations was generally between 4 and 7 miles. Another inconvenience that diminishes the transparency of the atmosphere more frequently than fog or rain, is the hazy glittering or quivering of the air, which, in our country, nearly always accompanies sunny weather; yet it will seldom thoroughly prevent signalling at distances under 7 miles, when the signallers are well trained, and the background is judiciously chosen, although the air is often less transparent during a sharp sunshine than during a slight rain.

Different instances have been previously mentioned of the enormous ranges at which signalling has been successfully performed, but this took place in other climates, where the pure and serene air affords far more favourable conditions for signalling than our hazy skies. Indeed, it cannot be absolutely denied but that there may also be days here on which signalling at wide distances may be possible, and it would be interesting to know the maximum distance possible under the most favourable circumstances; but in consequence of the great difficulties that signalling has had to surmount here, it has not yet been possible to gather sufficient experience upon this matter. Although such experience might be very interesting, yet a perfectly serene atmosphere is so seldom, and commonly of so short duration, that such wide distances as require a similar weather can only be used in a few exceptional cases; therefore distances approaching to the maximum ought never to be employed, unless circumstances make it absolutely necessary. This would only cause frequent interruptions and disappointments, and give credit to the charge of untrustworthiness, so often laid against visual signals. If this charge is to lose all real cause, it is necessary to lay the foundations of signalling on such short distances, that it may be carried on uninterruptedly, should even the atmosphere become somewhat hazy and quivering, or should there fall some rain. Only experience can decide how large these distances may be; with our actual *matériel* they can safely be made from 5 to 7 miles; but it ought to be observed that the telescopes employed are scarcely so good as they ought to be, and if they are improved, it is very possible that the distances can be made larger.

When the distance between two stations is rather wide, it is of the greatest importance that the backgrounds are well chosen, and the telescopes firmly placed. Uniform backgrounds with distinct, clear colours, very light or very dark, are the best ones; for instance, the sky, dark woods or heather, newly ploughed fields with a blackish soil, light green fields, white walls, &c., whereas broken backgrounds with indistinct and mixed colours like most houses, ripening corn, or stubble fields, &c., are very bad ones, and do not contrast distinctly with any flag.

If the telescope quivers ever so little, the distinctness of objects seen through it is much obscured; therefore it is to be placed safe from the wind, on the lee side of some hill or other elevated object; if, however, the wind is blowing directly from the other station, this is not possible, but nearly the same result is attained by placing the telescope directly before the said object—to the wind side—where the air is, so to say, stowed up and the wind scarcely felt.

Although the flash of the Spakowsky lantern is visible at far greater distances than the signal flag, yet the greater distance renders it more difficult to distinguish between the dash and dot; and as night stations must be established beforehand, and during the day-time, it will in most cases, with regard to practical causes, be preferable to use the same stations by night as have been used by day, perhaps with the sole exception, that a signal line of a length of 9 to 14 miles may, during the day-time, be served by three stations, while, at night, the intermediate station may be omitted, and signalling carried on directly between the two extremities of the line.

The quickness of the signalling especially depends on the skill and zeal of the signallers, and of the apparatus in use, though it is also influenced by the weather and distance. The more clearly and precisely the signals can be seen, the fewer mistakes and accidental losses of time will occur, and the greater will be the celerity attained. In our Telegraph Company, the ordinary rate for signalling between two stations is now between two and three words a minute with flags, and between one and two words with the lantern. Each station added to a line will delay the messages a little. This appears very slow in comparison with several statements from other quarters. But, be it observed, that this is the medium of a great many messages, sent while drilling the signallers, who the first times wanted more practice, and that the time is reckoned from the moment a message was begun until the last word was accepted by the receiving station, and the message ready for being forwarded to its place of destination. This is then the real average time that messages have been on the line, all loss of time by misunderstandings, and all time elapsed with pauses, &c., being comprised in the above-named time. Some knowledge of the quickness of signalling is indispensable to those who are to make use of it; for each useless word causes a loss of valuable time, and it is of the highest importance to make the messages as short as possible, especially where the distance is short, or else the message might be sent more quickly by a mounted orderly. Certainly signalling can be developed so that it may be conducted at a somewhat quicker rate; but when Major Le Mesurier has stated that, with the small flag lately introduced into the British army, a rate of ten words or more per minute is attained, he probably means only the time necessary for performing the signals at the sending station, without considering the delays and pauses indispensable in real signalling, so that the expedition of a message will, indeed, take somewhat more time. But if we bear in mind the fact that most messages might be finished within two or three minutes, even a rate of five words per minute will ensure the swiftness of signalling being superior to that of mounted orderlies at

any range from a mile and upwards even for a single message, and the more so when the number of messages is increasing. When the telescopes are of the best quality, it appears very probable that a much smaller flag than one of 4 feet may be employed at such ranges as our climate admits of, the more so, as it is easier to wave a little flag than a large one and so quickly that it presents its full size in whatever direction the wind may be blowing. The statement of English Officers, that signals are the more clearly seen the quicker the flag is waved, has been fully confirmed by experience in the Danish Telegraph Company.

Well-drilled signallers will carry on signalling through two or three intermediate stations almost as surely as between two stations, though somewhat more slowly, so we are enabled to extend a signal line over a distance of 19 to 30 miles. If a greater number of intermediate stations be employed, the line can be made still longer, but the probability of mistakes will increase; and by the actual development of the field telegraph, as well as of the permanent telegraph lines, it will scarcely ever be needed or advisable in our country to extend a signal line over a larger space. Most frequently the signal lines will be limited to a length of 10 or 18 miles with one or two intermediate stations, the electric telegraph being employed at wider ranges.

What distance should be regarded as the minimum length of a signal line depends on several circumstances, such as the rate at which signalling may be carried on, the length and number of messages sent, and the number of mounted orderlies at disposal. In this case it is the distances that the orderlies have to surmount, not the line of vision, that is to be considered. At the above-mentioned rate of two or three words per minute, the signal communication will be superior to orderlies, for short statements of five to ten words, at ranges of 2 or 3 miles, while orderlies may be preferable for messages of twenty-five or thirty words, at distances of 3 or 4 miles. If no mounted orderlies are to be had, a signal communication may be of great use at ranges of a mile. What has been said here refers to a single message only; if many messages are to be sent with short intervals, signalling will maintain a superiority even at somewhat shorter ranges.

Whilst the most proper zone for signalling thus lies between 1 and 4 miles' distance, it is relieved, at longer ranges, by the electric telegraph, and, at shorter ones, by mounted orderlies; but as the proper employment of all three means of communication depends on many other circumstances, there may be cases where the electric telegraph ought to be employed at shorter ranges, which are mentioned as suitable for visual signals, or that mounted orderlies ought to be employed at longer ranges than above-mentioned, or, perhaps, that visual signals ought to be employed at ranges commonly better fitting for one of the other means of communication. In any case visual signalling is, indeed, indispensable if there is impassable terrain of rather wide extent or hostile troops or inhabitants between the two points that are to be connected. They are, therefore, so frequently employed at sea and are an inestimable means of communication

between the army and navy, where both are to operate in concert. Other circumstances of consequence for the employment of visual signals are essentially different, inasmuch as the troops that are to make use of them, are—

1. In motion.
2. In positions.
3. In fight.

1. The army is moving. In this case there is a great difference between those lines of communication that are leading parallel to the front, that is to say, lines combining the different columns, marching in the same direction on various roads,—and the lines following the direction of the march and leading from the advanced parties of troops back to the main force. Both sorts of communications claim a considerable degree of mobility and swiftness; in the first case, an orderly will always have a much longer way to ride than the direct distance between the columns, the more so as these may often be separated by pathless, or small pieces of impassable terrain; in the second case, he will certainly be able to get quickly from one party to another as long as he moves in a direction contrary to that of the marching troops, but will be very slow in returning when he is to overtake and speed past them. For these causes signalling may be employed at short distances without being inferior to a communication by orderlies.

The electric telegraph will scarcely be well placed during the march; for even if the setting-up of the line be carried to such perfection as to follow the troops on their march, yet a station cannot be erected and earth-conduit established without some stoppage and delay. Still the telegraph may in certain cases be employed for communications along the road which a column is taking, where one station may stand still, but it is not possible to establish and maintain an electric communication between two columns in motion. The stations only can be established on preconcerted places or at preconcerted hours; the communication is interrupted while the motion takes place, and if one column meets the enemy the others can have no tidings of it. In fact it has been tried to keep the telegraph station wagons in constant communication, forming the earth conductor by the wheels touching the ground; but a very dry road is so good an insulator, that no current will pass. The only means of maintaining telegraphic communication between troops in motion would be employing a cable with two separately insulated wires. But cables are, on account of other causes, more and more abolished by the field telegraph. Thus, communication is during the march, especially in directions parallel to the front, chiefly to be maintained by visual signals.

One of the most difficult tasks that can be given to the signallers, is that they are to maintain a constant communication during the march between the different columns, and at the same time between the vanguard and main force of each column. If this task is to be performed to perfection, signalling must be possible during the movement. This is the case with the system of Pouget, but, on the other hand, the distances between his signallers are exceedingly short. Strictly

speaking, our *matériel* is not constructed with a view to signalling while in motion, yet it is by no means impossible to do so, and it has, indeed, been tried with success to send off messages with flags from the moving carriage; only it must be remembered, that the signals have to be read with the naked eye, as the jolting of the carriage prevents the use of a field-glass; therefore in this case the distance can scarcely exceed some 2 miles. If much is to be signalled, or if the distance is too great to permit observation of the signals with the naked eye, stations are to be established at proper places. A station is established within a couple of minutes, but sometimes there may be some delay ere communication is had. If, therefore, signal parties are to give full satisfaction during the march, it would be preferable that each of their respective commanders whom they are to serve had two completely equipped signal stations at his disposal, so that they might move on alternately, one of them always being stationary and having communication while the other is moving. As it is of the highest importance, when the army is in motion, that communication be established without any loss of time, and signalling carried on with the utmost possible speed, moderate distances—some 4 or 5 miles—are to be recommended for this case.

2. When the army has for some time held a *position*, it may be supposed that there will always be set up field-telegraphs between the permanent lines of the country and the head-quarters, as also from these last to the different army corps and divisions, perhaps even down to the brigades, and from them to their battalions on outpost; some have even planned an extension of the telegraphic net by means of the outpost telegraph, and the telephone to the videttes themselves. In any case the establishing of a telegraphic net of such perfection will require a certain degree of tranquillity in the position and a vast *matériel*, so it may be supposed that the electric lines will often stop at the divisions, at least on some places; thence to the outposts the communication in such case ought to be established by visual signals. But even with the most complete telegraphic net, there still remains sufficient room for those; their real activity is to be displayed in the most advanced zone, where engagements with the enemy are to be expected every moment. The most advanced outposts in front and especially on the flanks, but still more the cavalry patrols on the look-out, ought to be furnished with signal stations communicating with the troops behind. The strolling larger patrols and reconnoitrings ought to be accompanied by "flying" stations in communication with the look-outs in the outpost line. Great advantages may be derived from this precaution. The signal stations in the outposts can, with their telescopes, scan the country before them so carefully, that they can discover any suspicious movement at a distance of several miles, and in a few minutes they can inform the head-quarters of anything of consequence. The dispatched commands, too, can speedily give information about the result of their mission, and last, not least, it contributes greatly to their own safety, that the look-outs may observe them during their march and inform them of any hostile enterprise which may endanger their return, and which may often be visible from the elevated positions

of the look-outs, though hid from the troop concerned; or by informing the head-quarters of the peril, the look-out can cause assistance to be sent in due time. A brilliant example of this sort is shown from the late war in Afghanistan, where the signal station at Aliboghan, from an invisible distance of many miles, foiled by its information the enterprises of the Momunds. Though Denmark has had no war since visual signalling was adapted for field use, yet from practices in combination with other arms experience has clearly shown their usefulness.

3. During the battle, signal communications between different brigades or larger bodies will often be advantageous, but from the brigadier downwards, only under circumstances when the brigade extends over a greater space of room than usual, or is in want of orderlies. There are not so many data on record regarding this fact that a decisive opinion can be formed. Visual signalling will, during the battle, as in other circumstances, principally be fit for communicating with troops turning the enemy's flank or guarding our own flanks from being turned. A special application, and a very advantageous one, is for communication between artillery and the persons observing the effect of its firing, if it is at any distance. An instructive instance of this use of signals has been mentioned above from the attack of Fort Fisher.

It cannot be denied that the field telegraph has also been employed on the battle-field several times, and sometimes with great success. Such was the case during the battle of Fredericksburgh, where Franklin's corps had a telegraphic communication with the northern river side during the whole time the battle lasted. The same is told from the war of Paraguay against the allies, where telegraph stations were often worked in the very foremost lines during the action. But this ought scarcely to be recommended on a battle-field, unless the battle is rather stationary, or the side using them has good chances of success; where the troops are wavering backwards and forwards with the varying chances, or where defeat might be the most probable issue, it will cause too great a loss of *matériel* when so much of it is placed in the foremost lines. This, in fact, was the case in Paraguay, where by-and-bye all the *matériel* fell into the enemy's hands, and its loss was then bitterly felt. It is quite another thing in fortifications or well-fortified positions; there the telegraph ought to be employed to the utmost extent, and signals chiefly for communicating with points beyond the fortifications.

The rules for signalling that have been pointed out above will, of course, be subject to manifold variations, as the signals or the electric field telegraph becomes more perfected. To employ them in the proper way and at the proper place, it is necessary to be, at any moment, fully aware of their capabilities, as well as of their deficiencies, and a similar knowledge of the two other means of communication—the field telegraph and the orderlies—is indispensable. As both the field telegraph and the signals are from day to day more and more developed and perfected, this knowledge can only be had by those who, during the time of peace, are constantly occupied with

both of these branches of the service. Therefore the best plan would be to unite the field telegraph and signal service in one corps, whose chief during the war or grand manœuvres would be attached to the head-quarters as chief of the whole service of information and communication, and would decide whenever telegraphs, or signals, or orderlies were to be employed. In this way the service was organized towards the end of the late American war, at least in some of the armies, and it proved very satisfactory.

The development which the Danish signalling corps most stands in need of is the acquiring of a greater speed in the transmission of messages. Here is apparently something to be gained by accepting a smaller flag for short ranges as in England; neither is it impossible that a stiff disc, which would always display its whole breadth, might be preferable to the flag. The heliograph will always maintain, where it can be employed, an overwhelming superiority over all other kinds of signalling apparatus. Its chief fault is the necessity for sunshine; this fault is of great importance in our clouded climate; yet, in spite of this, it would even here be a very useful instrument to employ, besides the flags, for when it is nearly impossible to observe the latter in consequence of the hazy quivering of the air on sunny days, the flash of the heliograph will, no doubt, easily penetrate this slight, transparent sort of haze. But if it is to be introduced as the universal apparatus for signalling, it is quite necessary to have an artificial light, sufficiently strong to replace the sun, not only at night, but even on rather clear sunless days. The electric light, of course, would be excellent, and ought to be employed at fixed stations and on board ship, but the machines producing it are not yet sufficiently light and simple for field-use. It may be hoped that they may soon attain a sufficient degree of perfection. In France a simple petroleum lamp is used in connection with a concave mirror, but I have not been able to ascertain whether the light is sufficient for long distances in rather unfavourable circumstances, which appears a little doubtful. In 1879 an electric lamp was employed on board the Danish ironclad "Odin," while signalling with a station on shore. The flashes were given in turning the lamp to and fro, which was a rather slow proceeding, but the light was so intense, that it was scarcely supportable to the eyes when it fell directly on the shore station, which was at a distance of some 4 miles; it was plain that it would have been strong enough for a very long distance.

When the wished-for perfection of the electric light is attained, visual signals probably will be the best means of communication at any distance between 1 mile and 20 miles, messages being sent through the line at a rate of ten words per minute, or even more, in every weather but a pelting rain, a thick snow, or a dense fog. There then remains only one perfection that is to be attained for making visual signalling just as perfect as electric telegraphy. I mean the self-recording of the signals by the receiving apparatus. Nor will this be impossible with the heliograph as a sending apparatus. Suppose the receiving apparatus be a camera obscura, into which light can only penetrate through a rather long and very narrow tube;

then scarcely any light will come into the apparatus, except rays following exactly the direction of the tube. If the tube be directed exactly towards the sending station, any flash from the heliograph there will throw into the camera a sharp ray of light. If it strikes there a slip of paper prepared for the purpose by a chemical process, it will produce a discoloured spot, and if the paper is drawn slowly past the slit, through which the light is penetrating, the dashes and dots of the heliograph will be marked by long and short discolourings of the paper. The only difficulty is the preparing of the paper in such a way that the marks become sufficiently clear and can easily be rendered permanent, so that they are not blotted out on their being subsequently exposed to the light.

There is one complaint that is often brought forward against visual signalling, viz., that the signals run the risk of being intercepted by the enemy; but, in fact, this complaint is most commonly heard from those who have never tried signalling themselves. He who has experienced the difficulty of finding a neighbouring station of whose whereabouts we are not distinctly aware, knows that even a flag station is not so very easy to discover at some distance. Moreover, those messages, the interception of which might cause any harm, are nearly always sent *to the front* from more remote points in the rear, and messages of importance may be partly enciphered. The best use of the cryptograph is to encipher only so much of a message that it is incomprehensible, then there will in no case be a sufficient number of ciphers to enable the enemy's deciphering the message. With the heliograph an interception of the message by the enemy is nearly impossible, as he is obliged to stand exactly in the very narrow cone of light projected from the instrument if he is to see any signal. It is an interesting fact that during the American war no serious mischief was caused by the interception of signalled messages, while, as for telegraphic ones, many where intercepted, causing great trouble and disorder. Thus the famous raids of Morgan were made possible chiefly by an able telegrapher in his train, who intercepted the orders for troops sent on the pursuit, and in replacing them by false ones, foiled repeatedly the attempts at closing with Morgan's excursive party.

Friday, June 3, 1881.

MAJOR-GENERAL LORD CHELMSFORD, G.C.B., &c., &c., in the Chair.

## MOUNTED RIFLEMEN.

By CAPTAIN J. R. LUMLEY, Late 13th Prussian Uhlans and Lonsdale's Horse.

The CHAIRMAN: I beg to introduce Captain Lumley, who has kindly consented to give a lecture on this occasion on a subject which I think all will agree is a very important one. Captain Lumley comes before you with all the practical experience which he gained in a great campaign, he having taken part in the Franco-German war. He was present at the battles of Spicheren, Gravelotte, and Sedan; he also joined in the siege of Paris, and afterwards was with the force that operated along the Loire. Subsequently he went out to South Africa during the later phase of the Zulu war, and was employed in command of 200 or 300 colonial mounted infantry. He has thus obtained practical experience regarding the arm of which he will give us his views this afternoon. He belonged to the 13th Prussian Uhlans.

CAPTAIN LUMLEY—Though greatly appreciating the honour done me by the Council of this honourable Institution in being asked to read a paper on "Mounted Infantry," still I feel uncertain whether I shall be able to do justice to a subject of such great importance; one which, moreover, has until now only been assayed in various armies without any definite conclusion having been come to as to its practicability and organization, or the best means of carrying it into effect. Therefore, before entering on my own views regarding this,—I may say in the future—new branch of the service, I will first place before you a short outline of the past history and employment of "mounted infantry" at different periods and in various countries during peace as well as in war. By such means, I hope to give more valuable information than any I could presume to initiate.

Looking back to the earliest stages of military history, we find the necessity of rapidly moving bodies of infantry was early recognized and adopted, for we read that the Assyrian cavalry, 705 B.C., was composed with this object of spearmen and archers, the latter dismounting to fight on foot as soon as they were in close proximity to the enemy, while the spearmen remained mounted ready to follow up any success gained by their comrades.

During the Greek period, Alexander the Great, who was the first General that employed cavalry to any great extent, and whose fiery and impetuous nature led him to favour the cavalry service, as we find him, in nearly all his battles, opening the action at the head of his cavalry by attacks on the enemy's flanks, and invariably appearing at the decisive point with a victorious body of horsemen, nevertheless divided his cavalry into heavy-light and a body called "demachi," or mounted infantry, who were intended to fight both on foot and on horseback. The art of war, which had made great progress, clearly demonstrated the importance of rapid movements in anticipating an

enemy in seizing an important position, and Alexander, one of the greatest military reformers, at once recognized the advantages to be gained from a force such as described, and able to operate upon broken ground where chariots could not be used. Never has any General more fully proved the immense benefits to be derived from a mounted infantry force than did Alexander, when, after the battle of Arbela, hearing that the Persian King had fallen into the hands of his Bactrian satrap Bessus, he marched incessantly for three days, his infantry, from weariness, being unable to keep up, he dismounted 500 of his horsemen, and placing his Captain of foot with his best infantry on the horses, pushed on in pursuit, and coming up with the enemy early the next morning, totally defeated them. The energy with which this pursuit was carried out deserves great attention, for the fact of Alexander's dismounting a portion of his cavalry in order to enable him to take on his infantry clearly proves how much the great master of the art of war valued a Mounted Infantry force.

The Romans, who had imbibed Alexander's ideas as to the use of their cavalry, employed it exclusively for charging purposes, although we find an instance, during the wars of Hannibal, of the Roman knights leaping from their horses at the battle of Cannæ to fight the Carthaginians on foot. Julius Cæsar is also reported to have employed infantry mounted "*en croupe*" behind his cavalry, and on another occasion to have put 500 men of his 10th legion on the horses of his allies.

In the days of chivalry, when horsemen were mostly employed for all military purposes, no mention is recorded of mounted infantry, and it is not until the introduction of fire-arms that we read of them again as being employed by Marshal De Brissac, in 1550, under the name of dragoons. Thus the French seem to have been the first to revive the use of Mounted Infantry, and their example was soon followed by all European armies, but I may say with the same result, viz., that they became irregular, and, ultimately, regular cavalry.

During the Thirty Years' War, Gustavus Adolphus, who very much resembled Alexander in character, and who certainly adopted his ideas regarding the employment of cavalry, set about re-organizing their tactics, which were of the slowest and clumsiest type. He taught his dragoons to become famous in hand-to-hand engagements, and although they had been originally raised as mounted infantry, they were transformed into cavalry, and used solely for charging purposes. In like manner, the dragoons and carabineers of Wallenstein's army, who carried long muskets to enable them to act as infantry, seldom or never dismounted, but fired from their horses or fought as cavalry. The successes obtained by Gustavus Adolphus with his cavalry, which had been taught to depend entirely upon the keen edge of the sword and the shock of the charging men and horses, could lead but to one result, the suppression of mounted infantry, and the employment of dragoons in the duties for which they had been originally organized became obsolete, and continued so, more or less, till the end of the 17th century.

At the commencement of the 18th century a change again took place, when Peter the Great organized in Russia corps of dragoons for the double purpose of fighting on foot and on horseback. Their arms and equipment, being specially designed for the former purpose, consisted of a long musket, sword-bayonet, and pistol; a certain proportion carried axes, spades, and shovels, for cutting down abattis and throwing up field entrenchments when defending important posts. It would appear that Peter the Great perfectly understood the employment of mounted infantry, as he owed his brilliant victory at Pultova, and its subsequent results, to the masterly way he made use of this arm. I will give a brief description of the battle.

"The Czar covered his advance with 1,000 dragoons, who, coming "upon the enemy, dismounted and opened the engagement, but on the "infantry coming up they were ordered to form up in 'ordre de "'bataille' alongside of them, on the flanks. A severe struggle took "place, resulting in the defeat of the Swedes, who were closely "followed up by Prince Menzchikoff with a large body of dragoons "and cavalry, with infantry mounted *en croupe*. Coming up with them "on the banks of the Dnieper, which they were unable to cross, he "compelled General Lovenhaupt to surrender with 14,000 men."

It is worthy of remark that at one time the cavalry force of Peter the Great is said to have been 84,000 men; but it would, however, be fallacious to imagine that these were cavalry proper, as the greater portion were in reality mounted infantry, and raised for that purpose.

Marshal Saxe, who also recognized the advantages to be gained by an army having mounted dragoons, laid down a rule that they should be twice as numerous as regular cavalry, mounted on small active horses, the men being of the same stamp.

Frederick the Great, who has had few, if any, equals as a leader and organizer, like Alexander, Gustavus Adolphus, and Marshal Saxe, maintained that the strength of cavalry lay in their mobility and charging capacities, and to these qualities of his cavalry he owed the success of fifteen out of the twenty-two battles he won. Predisposed as he was in the opposite direction, still we find that after the battle of Rosbach, on the 6th November, 1757, coming up with his cavalry upon the retreating enemy, whose rear-guard was strongly posted in a country house, he ordered them to dismount, and succeeded in taking the position, carbine in hand. This use made by Frederick of his cavalry is instructive as showing that the highest appreciation for the "armes blanches" did not prevent his dismounting his cavalry and using fire-arms when necessity required it. On the accession of Frederick, cavalry had degenerated into masses of unwieldy horsemen charging at a trot, and firing when attacked from their saddles. He soon put a stop to the latter practice, by threatening to cashier any Officer receiving an attack standing, or allowing his men to fire with their carbines while mounted.

The wars of Napoleon tell us very little regarding the employment of mounted infantry or dragoons, the fact being that the latter had universally settled down into regular cavalry, and were employed as such. The only instance I find is when Suchet, in 1811, after the

battle of Valencia, having mounted his infantry behind his cavalry, successfully pursued Blake's retreating army.

I would now draw your attention to the fact that the Russians are the nation who have paid the greatest attention to the subject of mounted infantry, and consequently have gathered the most practical experience regarding it. That this should be the case is but natural, for in her wars Russia has always had vast extents of ground to get over, and has therefore been taught the urgent necessity of facilitating the movements of infantry.

Thus far, I have contented myself with placing before you solely historical facts, but I must now give somewhat minuter details of the Emperor Nicholas I's organization of a dragoon corps, to be employed in the double duties of infantry and cavalry, but principally as the former, the horses to be considered solely as the means of quickly transporting the men from one place to another. With this idea, he raised a Dragoon Corps, consisting of two divisions, each division having four regiments, 2,000 strong. The regiments were divided into ten squadrons, eight of which were armed as infantry, with long-range muskets and sword-bayonets; the remaining two squadrons, having lances, formed the cavalry of the corps. The divisions were to remain intact in time of war, and to be used for the purpose of flying columns, horse artillery being attached to them. Kaiser Nicholas so far carried out this idea, that some years afterwards when he assembled them for manœuvres at Wassnessensk, the Prussian officers on the staff of Prince August, who witnessed the operations, were most favourably impressed with what they had seen, and declared the Russian dragoons to be first-rate infantry, as well as serviceable cavalry. Their tactics were to approach, if possible unperceived, the flanks of the enemy, taking the greatest care to keep well behind any objects of shelter; dismounting quickly they would form up into battalion columns from the right or centre, and advance under cover of their skirmishers. The horses were carefully kept out of sight, and the cavalry of the corps were employed to protect them against any sudden attack from the enemy's horsemen. If the attack were unsuccessful they would retire on their horses and gallop off as rapidly as possible, and endeavour to seize a more favourable opportunity at some other point of the battle-field. They marched in sections of threes, and dismounted in front, and column formation Nos. 1 and 3 dismounting, No. 2 holding the horses, who remained under the command of the second senior Officer. The favourable impression created in Berlin by the manœuvring of the Russian dragoon corps induced Colonel von Barner, commanding the 1st Regiment of Dragoons of the Guard, to endeavour to similarly employ the five regiments of Prussian dragoons. While recognizing the organization of corps of mounted infantry, as an important element in future warfare, Colonel von Barner was not satisfied with copying the Russian ideas, but set about to perfect them by making the corps entirely independent of the Commissariat and Transport while undertaking extended operations. He provided a fourteen days' ration for the men, which they carried with very little inconvenience, but when he came to adding oat cakes and compressed

forage for the horses, it was found to be impracticable, inasmuch as the troops would be incommoded by it in their rapidity of movement. Although the Prussian dragoons remained cavalry, the failure of the scheme was principally due to the Officers, who objected to become foot soldiers. Still the experiments tried by Colonel von Barner were not without some advantage, for to them the Prussian army owes the introduction of the "Erbswürst," which proved so efficacious during the Franco-German campaign.

When the Crimean War broke out, everybody was anxious to see the practical results derived by the employment of the Russian Dragoon Corps, which at that time numbered 16,000 men. But disappointment followed, as it was never so employed in its double functions, and when the war ended, Emperor Alexander II broke it up, and distributed the regiments among the cavalry divisions; thus, as in all preceding instances, they became regular cavalry. However, I do not think that the Crimean campaign was one by which the employment of mounted infantry could be fairly tested, as the operations on both sides were more or less confined to siege exploits.

We now come to the American civil war—a war very rich in the doings of "Mounted Infantry," for it would be an injustice to cavalry to call the mounted levies raised on both sides by any other name. When we remember that the entire mounted force in America on the outbreak of hostilities was one regiment of regular Northern Cavalry, and that before its conclusion 150,000 mounted men were in the field, most of them armed with rifles, we can form some conception how much importance the American Generals attached to such troops; but we must bear in mind that neither side possessed what would be called, in Europe, a cavalry force, which, no doubt, greatly facilitated their mode of warfare, while at the same time it allowed them to show us how Mounted Infantry could advantageously be employed in similar circumstances, as well as, if properly supported, by regular cavalry, also in European warfare.

To the Confederate General Morgan is attributed the first recognition of the great value mounted men, armed with a rifle, revolver, and sabre, would be in American warfare, and he raised and equipped, as I have just mentioned, several hundred men. Although he was not himself a trained soldier, still we can but profit by his ideas, which are worthy of consideration on account of their simplicity and practicability. When mounted, his regiment was drawn up in single line, when advancing, mounted skirmishers covered his front, and if necessary to dismount, he always did so under their protection, one man out of every four remaining to hold the horses, a body of mounted men being always kept in reserve to guard the flanks and horses, as well as to cover a retreat or press a victory.

General Duke describes Morgan's manner of fighting in the following terms:—"The nature of the ground on which we generally fought, "covered with dense woods, or crossed by high fences, and the impossibility of devoting sufficient time to the training of the horses, "rendered the employment of large bodies of mounted men, to any "good purpose, very difficult. It is very easy to charge down a road

"in column of fours, but very hard to charge across the country in "extended line, and long guns were not exactly the weapons for "cavalry evolutions. We found the method of fighting on foot more "effective, we could manœuvre with more certainty, sustain less and "inflict more loss."

It must be remembered that General Morgan very rarely fought with the army, he had to make his force a self-sustaining one, and therefore he found it necessary to have horse artillery attached to his mounted corps. It would occupy too much time to enter minutely into all General Morgan's operations, so I must only refer to one or two briefly.

"Starting from Knoxville on the 4th of July, 1864, he reached "Medway on the 12th, having marched 300 miles in eight days; such "was the extreme mobility of his flying column that the enemy were "unable to obtain any correct information of his intentions or where-"abouts. The result of this raid I had better describe in his own "words: 'I left Knoxville on the 4th July, with about 900 men, and "'returned to Livingston on the 28th with nearly 1,200, having been "'absent just 24 days, during which time I had travelled over 1,000 "'miles, captured seventeen towns, destroyed all the Government "'supplies and arms in them, dispersed 1,500 home guards, and "'paroled nearly 1,200 regular troops. I lost in killed and wounded "'about 90 men.'"

Like all amateur soldiers, General Morgan, elated with success, forgot the necessity of being cautious as well as enterprising, and was finally cut off and made prisoner, with the greater portion of his command, while on a similar raid a year afterwards.

General Forrest's expeditions, General Stuart's great sweeping reconnaissances, and the cavalry operations of Grierson and Wilson, are well known to most military readers, so I must pass them over for want of time, so as to enable me to make a few remarks on the operations of General Sheridan's corps of mounted riflemen, for their operations very materially contributed to the surrender of General Lee's army at Richmond and to the termination of the American War.

On the 29th of March, 1865, General Sheridan set out with 10,000 mounted men to carry out his great turning movement of the right flank of the Confederate Army. A severely contested fight occurred on the 31st, when he successfully resisted a combined attack of all three arms with his dismounted horsemen, at Five Forks, while, on the 1st of April, he stormed and carried the enemy's position with three of his brigades, General Meritt, with the reserve brigades, taking up the pursuit, captured 6,000 prisoners, and caused a total loss of 13,000 men to General Lee's army. This battle of Five Forks virtually decided the fate of the war, for General Lee evacuated Richmond, and retreated in the direction of Danville, vigorously pursued by Sheridan's cavalry, who, seeing that the Confederates' force was too great for him to defeat by a direct attack, swept round its flank, crossing Sailor's Creek before it, took up a position across the road on the far side of the stream and, dismounting, disputed General Lee's passage of the stream. Operating in like manner at Lynchburgh, he got the Confederate Army between

his and General Grant's forces, and thus brought about the surrender of the whole Confederate Army at Oppomattox Court House on the 9th of April.

The war of 1866 does not furnish a single instance of the employment of dismounted cavalry, but "Jägers" (riflemen) were attached to some of the reconnaissances carried out by the light cavalry. There is an old saying in Austria, bearing on the co-operation of these troops: "That the left stirrup of the Hussar belongs to the Jäger," meaning that in case of necessity the latter would take hold of the Hussar's stirrup and would thus be able to get over the ground more rapidly. The Franco-German campaign opened a new era for cavalry, whose prestige had greatly suffered after the Austrian war. Officers were not wanting who were only too ready to assert that the days for its employment were passed and that it could not be of any use in these times of Chassepôts and Henry-Martinis. But the admirable way in which the German cavalry performed the outpost, reconnaissance, and advance guard duties not only proved its indispensability to any properly organized army, but the battle of Mars-la-Tour will ever bear evidence that properly trained and handled cavalry can act successfully against infantry and artillery, even in these days of long-range breech-loading rifles. It was entirely due to the noble conduct of the 5th and 6th Cavalry Divisions that Marshal Bazaine was prevented from continuing his march to Verdun and ultimately joining Marshal MacMahon at Châlons, for by their repeated attacks he was obliged to accept a battle, and thus allowed time for the German infantry to carry out their turning movement, which ended in his being thrown back into Metz.

In my opinion, the battle of Mars-la-Tour, if compared with Sheridan's movements after the engagement at Five Forks, speaks greatly in favour of the employment of mounted infantry. Although the object in view was obtained in the former battle, by the noble sacrifice made by the Prussian cavalry, still, although a cavalry Officer, I cannot help admitting that the same result would have been obtained at a very much less expenditure of life and money had mounted infantry been employed.

In the first phase of the war, I had no personal experience of the French cavalry fighting dismounted, although they had many regiments of Chasseurs d'Afrique and Chasseurs-à-Cheval intended for this purpose. On the other hand, there is a record of the 3rd Zieten Hussars dismounting and successfully attacking, on the 29th August, the village of Voucq, which was strongly occupied by the rear-guard of Marshal MacMahon's army. It was, however, during the winter campaign on the Loire and in the North, when nearly the whole country was infested with Francs-tireurs, that the Prussian Uhlans began to feel the want of a rifle, for their patrols were daily forced to retire before or give a wide berth to villages and woods occupied by a handful of men who had come out "pour faire la chasse aux "Prussiens," to use their own expression. I may here be allowed to relate a small incident that occurred to myself

On the 23rd of December, the 11th Cavalry Brigade, consisting of a

cuirassier, dragoon, and Uhlan regiment, was brought to a standstill before the village of Vibray. The dragoon Officer in command of the advance guard reporting the village to be occupied by infantry, General von Barby decided, as it was getting dark, to bivouac his brigade for the night before the place. The next morning, my squadron relieved the dragoons and took the advance guard of the brigade, I being ordered to command the advance guard of the squadron. The orders I received were, Vibray is still occupied, if you are fired upon, send one man back to report, leave two to watch the road we are advancing on and gallop through the town with the remainder. We were fired on, and I galloped through the town, receiving a parting volley, fired from their horses, by a dozen Chasseurs d'Afrique, who then made off in the opposite direction. Here is an instance of a whole cavalry brigade stopped by 12 mounted riflemen, an impossibility had it been accompanied by Mounted Infantry.

What the German opinion may be regarding the utility of mounted infantry I cannot say, as opinions vary greatly on the subject, but it is certain that the experience gained during the war of 1870–71 placed beyond contention the absolute necessity of arming the cavalry with rifles, and they all now carry, in a bucket attached to the right side of the saddle, the cavalry carbine known as system M—71. It is 1 metre long, weighs $7\frac{1}{2}$ lbs., and is sighted up to 1,300 metres or 1,430 yards.

Let us now consider the lessons to be gathered from the past history of mounted infantry, and endeavour to form a clear perception of their utility, and if so, of their necessity. The outlines I have placed before you clearly show that not only in modern times, but also in past ages, all great Generals have recognized the necessity of being able to move bodies of infantry with as great rapidity as possible, as well as spare them the fatigues necessarily entailed by forced and extended marches. The Greeks, the Romans, the Persians, and, at some time or other, all the military Powers of Europe, have resorted to various means to carry this principle into effect, and the instances I have quoted bear strong testimony to the great utility mounted infantry have been whenever and wherever employed. During the American war, so admirably were they made use of, that not only did they fight, dismounted, sanguinary battles, but also most effectively performed the reconnaissance and outpost duty of cavalry.

Colonel Denison, in his admirable work on "The History of Cavalry," speaks of the American mounted levies both as cavalry and mounted riflemen, and holds forth their doings to illustrate his favourite idea that mounted infantry should be a dualistic arm, both infantry and cavalry, but I maintain that calling these American levies cavalry is a misappropriation of the word, for cavalry, to be used effectively as such, cannot be raised and trained in one or two years. The following quotation from Colonel Denison's work will, I think, bear out what I say:—

"Another reason led to the introduction of mounted riflemen, that "will seem strange to the European reader, particularly to the Euro-"pean cavalry Officer. There is no principle more firmly established

"among professional writers on cavalry tactics, than that the sword is "the most deadly and effective weapon that can be placed in the hands "of a horseman. The moral effect of horsemen charging sword in "hand is very great in all European armies, and no principle is laid "down more positively than the maxim that cavalry relying on fire-"arms must certainly be beaten. In America, strange to say, the "exact reverse is the fact. There the people had the greatest con-"tempt for the sword, their small force of regular cavalry, trained on "the European plan, alone placing implicit confidence in it. The habit "of the individual citizen of being armed with a revolver, and having "almost always a rifle of his own, gave them naturally a high opinion "of their favourite weapons. At once a feeling of contempt for the "sword sprang up in the Southern army, and although at the outset "of the war the Northern cavalry used the sabre, the Southern troops, "both mounted and dismounted, so despised the weapon that nothing "could make them give way to a charge of cavalry, sabre in hand."

He further states that when the Southern infantry saw the cavalry advancing to attack they would remark, "Here, boys, are those "fools coming again with their sabres; give it to them! and that the "Southern cavalry, who were at first simply armed with double-"barrel fowling-pieces, would charge at speed at a line of hostile "cavalry, firing both barrels into the enemy's faces, and then dash "through, striking with the butts of their guns."

Besides differing from Colonel Denison in the appellation of these levies, I must also differ from him in his opinion "that European "cavalry Officers consider the sword the most deadly and effective "weapon that can be placed in the hands of a horseman," for it is universally admitted that the lance is the queen of weapons and the most dangerous, this being confirmed by the statistics of the killed and wounded by these weapons respectively during the Franco-German War. It certainly must have been very indifferent cavalry who allowed a body of mounted men, armed with fowling-pieces, to discharge them in their faces and proceed to belabour them with the butts. I am able to bear testimony, from personal experience, against the American notions expressed in this quotation, for at the battle of Mars-la-Tour I had the good fortune to be among those who were present in the great cavalry charge that took place on the extreme Prussian left just before sunset. My regiment, lancers, was opposed to "Les Dragons de l'Impératrice," who received our attack standing, firing from their horses with their carbines, but long before they could belabour us with the butt-ends or even draw their swords, which they endeavoured to do, we had completely ridden them down, and those who were not killed or wounded were made prisoners, minus their horses, which had escaped, their riders having been unseated. Our loss in this attack was very small, and that of the French very severe. Not so well fared the 19th Dragoons, who were opposed to French lancers; their loss, both in Officers and men, was very considerable. The conclusion I have formed is, (1st) that it is culpable folly to fire from the saddle, and that the Officer who allows his men to do so should be made an example of; (2nd) that nothing is more difficult, even to

a perfectly trained trooper, than to use a sword effectively on horseback when opposed to an enemy using either lance or bayonet. It is my opinion that mounted infantry should be solely infantry, and employed to act as such in conjunction with cavalry and if necessary horse artillery, their horses being the means of rapid locomotion, nothing more. If these ideas be strictly carried out, great benefit would accrue from the formation of mounted infantry corps, as speed in movement is one of the greatest elements of success in war. So much was the great Napoleon imbued with this idea, that he expressed the opinion that an army of 10,000 men which could average 20 miles a day would conduce as much towards the success of a campaign as one of 20,000 moving only 10 miles a day.

The reconnaissance, patrol, and outpost duties now done by cavalry can be equally if not better performed by properly trained mounted infantry, while they would be of much greater service in escorting and protecting convoys. As mounted orderlies, they would be found quite as useful and much cheaper than a trooper. I think, taking everything into consideration, there can be no question as to their utility. The necessity of organizing corps of mounted infantry is a subject which calls for the greatest attention from all military reformers and writers in all countries, but especially in England, whose wars are not usually fought in Europe or confined to European tactics, but are mostly waged in tropical climates, where the marching powers of her infantry and the utility of her somewhat heavy cavalry are greatly affected by these circumstances. I would even go further and say that the present training and organization of the English cavalry necessitates the organization of mounted infantry corps. While discussing this question, which I do from an entirely English point of view, I would bring to your consideration the following questions: 1. Who is to be our enemy? 2. Can we do without mounted infantry?

In answer to the first question, I would venture to say that the probability of England being engaged in a continental war is very remote indeed, but on the other hand, if she wishes to maintain her foreign possessions she must be prepared to defend them by force of arms, for their loss will be followed by the loss of her commerce, and by the loss of her wealth. What I would imply by the foregoing observation is, that England will encounter her future enemies not in Europe, but in Asia, Africa, and perhaps Canada. In these countries, great distances will have to be traversed and the motive powers of the troops more or less influenced by climate. What I particularly wish to do, is to call your attention to the not very remote probability of a Russian advance into Afghanistan and a subsequent invasion of India.

None but those who are blind, because they will not see, can believe that the Russian conquests in Central Asia have no ulterior object than the subjugation of the Turkomans. Were I not diverging too far from my subject, I would tell you what Russian Officers have told me regarding these expeditions, but as I am unable to go into details, I will briefly say that they acknowledge India to be their object. I will therefore draw your attention to the enemy we shall meet when

this time comes, which will show my reason for attaching so much importance to the question, "Who is to be our enemy?" as that enemy will certainly possess a very large force of mounted infantry, and it may not be uninteresting to you to hear some particulars about them. My authority, Fadiejew, whose article was published in the Russian language, and therefore is little known, begins by quoting a conversation between Napoleon and Admiral Pulteney Malcolm on the island of St. Helena:—

"If you do not take care," said Napoleon, "Russia will surpass you "all; she has already so organized her forces that great conquests "can be undertaken by scattering over Asia her light troops the "Cossacks.

"It is impossible," replied the Admiral, "to call Cossacks good "light troops." "Do not be mistaken," replied the Emperor, "they "are most useful, and first-rate in guerilla warfare. They are here, "there, and everywhere, attacking you to-day, to-morrow you cannot "find them, finding their way through foreign countries without "knowing the roads or the language. They are at home everywhere, "and live on their plunder. I was never able to make Cossacks "prisoners."

On the south-eastern frontiers of Russia live 250,000 Cossacks fit for military service, besides as many more horsemen of various other tribes. All these men are cunning, quick, and born riders; it is therefore unnecessary to teach them to ride. They would appear to be Nature's mounted riflemen. There are at present in Russia 20 million horses, so there would be no difficulty for her to place if necessary 300,000 mounted Cossacks in the field, the cost of which would be very small, as the law obliges every Cossack to furnish his own horse and accoutrements, although of late years they have been given breech-loading rifles by the Government. In 1875, the Don Cossacks, numbering 150,000 Officers and men, were organized as mounted riflemen, and no doubt this organization has also been adopted for all Cossacks, for in the official returns all those engaged in Turkestan are put down as mounted riflemen. It is therefore certain that, in the event of war, Russia would meet us with great numbers of mounted Cossacks, organized into flying columns, which would harass our flanks and destroy our lines of communication, if we are unable to meet them on equal terms. Now this appears to me sufficient reason for the organization of mounted infantry corps in the English army.

With regard to the question, "Can we do without them?" I say no, not only for the reasons I have already mentioned, but also because the English cavalry, as at present organized, is far too costly to be employed as mounted infantry, were it willing and capable of doing so; but putting the economical view aside, cavalry should never be asked to engage infantry dismounted, except as a surprise or to gain information, but never for offensive purposes.

Before entering on the duties and organization of mounted infantry, I must refer briefly to the often-proposed idea of conveying riflemen in carts so as to enable them to operate with cavalry and horse artillery. I must confess that the proposition finds little favour with me, for

the simple reason that I have seen it tried unsuccessfully. We found that the waggons invariably hampered the movements of the cavalry, and that moreover it was impossible to get them where most wanted. Conveying riflemen in waggons would be always a difficult matter in a country having good roads, but absolutely impossible and useless in one without them. The employment of camels is all very well on an emergency, but there are also many objections to it, such as the expense, the difficulty of mounting and dismounting, as well as the fact that camels cannot always go where horses can, nor be found in every country.

Every true soldier should be without prejudice, and although I have served in the cavalry all my life and have the very highest opinion of its capabilities if properly handled, still I am forced to acknowledge the necessity of organizing corps of mounted infantry, especially in England, for reasons I have given.

The principles on which mounted infantry should be organized are, firstly and foremost, that they are infantry pure and simple, having horses solely for the purpose of locomotion; secondly, that they should under no pretext whatsoever engage or receive the attack of an enemy otherwise than as infantry; thirdly, that they should always act as far as possible in large bodies; fourthly, that to every mounted infantry battalion should be attached a squadron of cavalry; for while advocating the employment of mounted infantry, it is far from my intention that they should in any way interfere with the offensive duties of cavalry, but rather, by co-operating together, render the services of both more effective.

Cavalry Officers should not be employed with mounted infantry, for it would inevitably lead to the destruction of the purpose for which such corps are organized.

I will now lay before you my ideas regarding the organization and employment of mounted infantry. I may be too confident in saying so, but I believe if some similar system were adopted by the authorities, it would be found of the greatest service in the English army. A corps of mounted infantry should be organized so as to act at any moment as a flying column. I would therefore recommend the following formation: four battalions of mounted infantry, one regiment of cavalry. Each battalion to consist of four companies of 240 men each, the cavalry to consist of four squadrons numbering 160 troopers each. This would give an effective force of about 4,000 men, which should in time of peace be taught to act together, and have a permanent staff, under whose direction it would act in time of war. The company and squadron should be the unit, commanded by majors, who should be responsible for the efficiency of their companies and squadrons respectively. The appellation "battalions" and "companies" should be strictly enforced, otherwise the thin wedge to the ultimate failure of the object for which mounted infantry should be organized will be inserted. A captain and three lieutenants should be the remaining complement of a company. The adjutant should be the colonel's aid in carrying on his office work and in no way be allowed to interfere with the drill and interior economy of the companies, which

should be left entirely to the major and his officers, the former being responsible to the colonel for all he does.

In every war, the side that has the best system of reconnaissance, outpost and advance guards, must have a very great advantage over its adversary. Now, for all these duties, mounted infantry can be employed equally well as cavalry, and by making use of them in such a way a very formidable screen could always be kept in the front of an advancing and in the wake of a retreating army. For escort, convoy, and mounted orderly duties they would be invaluable, answering the purpose of both cavalry and infantry. The destruction of railroads and telegraphs would particularly lie in their sphere, and I would recommend that a certain number of men in every company should be provided with the necessary tools for this purpose, as well as with hatchets, and the means of safely carrying dynamite cartridges for the destruction of bridges, &c., &c. The Prussian cavalry was, some years since, provided with all the necessary means for carrying out such operations. I do not think that entrenching tools should be carried by mounted infantry, who, being especially a mobile body, should be taught to take advantage of natural shelter and not to erect artificial protection.

On the cavalry, attached to mounted infantry, will devolve very important and responsible duties, such as protecting them when mounting and dismounting, guarding their flanks and horses from any sudden attack of the enemy's cavalry, keeping them well informed of what is going on while they are fighting dismounted and following up and gathering the fruits of a victorious and covering an unsuccessful engagement.

As I have before said, mounted infantry should be drilled entirely as light infantry, the greatest attention and importance being attached to their being first-rate marksmen, any soldier who is unable to obtain a fixed standard of efficiency as a marksman should be removed to some other branch of the service, as he would be useless as a mounted infantry man. Their mounted capabilities, beyond being able to ride and care for their horses, need be of the most primitive kind. Their drill, when in the saddle, cannot be too simple; I would therefore recommend a single rank, which has the advantage of making all movements easier to learn and carry out. In fact, their whole mounted evolutions need not extend beyond being able to mount and dismount both in front and column formation, to increase and diminish their front, to wheel fours right and left and to advance by fours and twos from the right or left; but these should always be carried out with the utmost rapidity, order, and accuracy. Three out of every four men can be conveniently dismounted, Nos. 1, 2 and 4; No. 3 taking charge of the horses; those of Nos. 1 and 2 with the right hand, and that of No. 4 on the bridle arm. I would recommend that, in dismounting, the even numbers should *advance* a horse's length and not *rein back*, the former being more natural to the animal, and easier with indifferently broken horses. It is my opinion that a mounted infantry corps, to be efficient, should be, as far as possible, independent of army transport or, in other words, able to carry its own

necessaries. To do this, every man must be mounted, and as the horses are never to be used for any purpose but that of rapid locomotion, they should be small and active, up to fourteen stone, not in a hunting sense, but in proportion to the weight carried by our cavalry. The advantage of small horses are twofold: first that they are cheaper, and secondly that they are better adapted for mounted infantry purposes on account of their being easier to mount and dismount. English Cobs and Galloways are my *beau idéal* of the kind of horse that should be given to mounted infantry, but if too expensive, Hungary and Galicia produce hardy little horses that would answer the purpose well, and could be obtained cheaply. In India and Africa, ponies such as required for mounted infantry purposes can be both cheaply and easily obtained. Two or three weeks at the outside are necessary to break them in for all the purposes requisite for mounted infantry, in fact, as soon as they allow themselves to be backed, the remainder of the breaking comes of itself. I will later on relate my experience on the subject. The horse equipment of a mounted infantry man should be as simple as possible, without any kind of polished strappings.

*The saddle* should be that known as the "Cape saddle," a plain hunting saddle, with fans projecting behind. Ten "D's" should be riveted on the tree, two on each side of the seat, three at the back, and three in the front. Attached by the "D's," at the back of the saddle should be a brown waterproof canvas valise, capable of containing a change of linen, a light camp jacket and trousers, a pair of shoes, a forage cap, and the man's toilet necessaries. On the right a brown canvas waterproof saddle-bag to carry the man's rations; on the left side, enclosed in a like waterproof covering, the man's cooking and eating utensils. Canvas wallets for the purpose of carrying extra ammunition and rations should also be employed. A folded blanket should be used instead of a numnah, as it is equally effective in preventing sore backs, while at night it acts as a covering for the horse, a thing as necessary in warm as in cold climates.

The bridle should be a strong, double reined one, with a plain snaffle or Pelham bit, so made as to act also as headstall by removing the latter. A good African rehm should be used for the purpose of attaching the horse to the picketing line; the latter need not be so thick as that employed by our cavalry, but similar to that used by the Prussian cavalry, which is carried attached to the saddle. To the right front of the saddle should be attached a strong leather bucket, for the purpose of taking the man's rifle.

Various suggestions have been made as to how mounted infantry should be armed, but as most of them advocate the use of the sword, carried either on the saddle or by the man, I must give my veto against its employment, as it will inevitably lead to the failure of the object for which they are organized and for which they are alone serviceable, to act as infantry. A mounted infantry man should be armed with a rifle and sword-bayonet similar to that employed by the Prussian Jägers, of which I give the principal features:—Weight —$7\frac{1}{2}$ lbs.; Length—1 metre; Sight—1,300 or 1,430 yards.

The sword-bayonet used by the Prussian Jägers is $2\frac{1}{2}$ feet long, and weighs $1\frac{1}{2}$ lbs. It is essential for the health of the men that the rifle should be carried in a bucket attached to the saddle, for do what you will, it is impossible to fix it slung across the back in such a manner that it does not move about. The trials made in both Russia and Prussia prove that the permanent motion of the rifle affected the men's lungs.

The equipment of the men should be similar in colour to that of riflemen, so as not to be immediately recognised by the enemy, and moreover, I think dark green is the most practical colour. It is essential that they should be cut so as not to hinder free action, and a Norfolk jacket has both a military appearance as well as the advantage of in no way interfering with the action of the wearer. I think something of that kind would be found the most useful. Pantaloons and gaiters to be the lower garments, the former to be made loose, especially from the knee, so as not to interfere with the man's movements when dismounted. Lace boots, infantry helmet, and strong leather belt, to which should be attached a frog for the sword-bayonet, and on each side a soft cartridge pouch, capable of holding 25 rounds of ammunition. This belt should be supported by crossed straps, so as to remove the weight from the man's hips, which is essential. The greatcoat would be either strapped over the pummel of the saddle or rolled up and slung over the left shoulder.

The men should be small, active, and intelligent, and, so as not to interfere with the recruiting of other branches of the service, a lower standard than that of the infantry should be taken.

Such infantry Officers only, who shall after 3 years' service with their battalions be especially recommended by their colonels on account of their general intelligence and efficiency, should be eligible for appointment to mounted infantry corps, but they should previously be attached for six months to a cavalry regiment to learn not cavalry duties, but to ride, if they are unable, and the management of horses and stables. It cannot be too strongly impressed upon mounted infantry, both Officers and men, that their utility will greatly depend on the efficiency of their horses, which can be maintained only by the greatest attention to their management and proper saddling, sore backs being the consequences of negligence on the part of both.

Time will not allow me to go into the economical advantages which would accrue by the organization of mounted infantry corps, but I may say that if the idea had been previously acted upon, the nation would have been saved the great sums of money which it cost to raise corps of mounted riflemen (irregular horse as they were called) during the South African wars.

I had the pleasure of commanding 200 or more of these mounted riflemen during the Zulu war, and may as well give you the benefit of my experience, which I am sorry to say was very small, for just as they were beginning to become efficient, they were disbanded. Never shall I forget the day I started from Durban for the Tugela with my squadron of mounted riflemen, "horse marines" would have been a more appropriate name, as two-thirds of them were runaway sailors. They

had saddled their horses by building up a small mountain in front and behind, which led me to think that if ever they once got into the saddle there was no fear of their falling off, but in this I was mistaken, for after having with the aid of two friends got into the saddle, and the horses' heads being let loose, they capered like a wild herd all over the place, and in less than five minutes nearly the whole of them were biting the ground. After much difficulty, I managed to get them to the Tugela, nearly all the horses having sore backs, but whether the horses' backs or the men's seats were the worse I will not venture to say. What was I to do? for it was a heart-breaking position to one who had come all the way from England to try and serve his country. I determined to make the best of it, by instilling in each man a love for his horse and by showing him how useless he was as long as his horse was unfit to be ridden. As soon as it was well, I taught them to sit and saddle properly, and in this manner by little and little arrived at the result which I am about to quote, not in any way to sing my own praise but to show what can be done in a very short time in very unfavourable circumstances. General Crealock, in his despatch dated Fort Durnford, 21st July, 1879, says, "I must especially mention Captain Lumley and his Officers, for, notwithstanding the bad condition of his horses when he received them, he has succeeded in the field to get his troops into most serviceable condition, and, notwithstanding the long patrols and hard work they have performed—'no sore backs.'" Colonel Clarke also speaks in the highest terms of the services rendered by these men in the long patrols after Cetawayo and subjugation of the tribes about the middle drift of the Tugela.

Here were men, who, although they were totally unable to ride, in a few weeks became horsemen enough to perform the duties of mounted riflemen, and though they at first perfectly disgusted me, after a few months I parted with them with the greatest regret, for they had then become an efficient body.

I hope the Government will no longer act upon the "penny wise and pound foolish" principle, but see the necessity of organizing corps of mounted infantry, and in doing this, *insist that they are infantry, not a dual arm.*

While thanking you, my Lord, ladies, and gentlemen, for the kind attention you have given to my paper, I beg to express my acknowledgment to Colonel Denison for the valuable information I have obtained from his writings while preparing this lecture.

The CHAIRMAN: The lecture which we have just listened to, with, I am sure, very great interest, opens out a large field for discussion, and I hope that Officers here who take an interest in this question will give us the benefit of their opinions regarding the several points upon which Captain Lumley has touched.

Colonel Sir ROBERT LOYD LINDSAY, V.C., K.C.B., M.P.: My Lord, I have attended the lecture with great pleasure, and I observe with satisfaction that it is given at the request of the Council of this Institution. I think that, in itself, is a matter with which we may be well pleased, because it shows that the Council wishes to bring this important subject before the public and before Her Majesty's Government. I am sure that they could not have selected an Officer more capable of bringing this matter forward than the gentleman who has just addressed us. His observations are

especially valuable because they come from a man who has been in the field, and who has practised the things which he comes here to tell us of. In his lecture, he goes back to historic times, and shows us how Alexander the Great, Gustavus Adolphus, Frederick the Great, and indeed, many of the great commanders of old, attached much importance to being able rapidly to move troops under their command. It is somewhat remarkable (as mentioned in the lecture) that Napoleon, although the lecturer spoke of him as using Mounted Infantry to a certain extent, neglected to make greater use of the advantage of that branch of the service. It is perhaps difficult to say how it was that so great a General as Napoleon did not avail himself of this means of moving his infantry more rapidly. I think it must have been because the dragoons at that time grew into bad cavalry and, while endeavouring to turn themselves into cavalry, forgot their duties as infantry. That may have been the cause of failure, and Napoleon, in disgust, set them aside and did not use them as otherwise he might have done. In his lecture, the gallant lecturer has given us some details of his experience, and if time had permitted we should have been glad to have heard a few more of those interesting accounts, especially of that incident he mentions as having taken place at Vibray, where a regiment of cuirassiers, a regiment of Uhlans, and a regiment of dragoons were held in check for a whole day by twelve Chasseurs d'Afrique. It seems curious that such a practical nation as the Prussians should persevere in keeping cuirassiers in their service. I never could make out how a cuirassier could put a rifle to his shoulder; perhaps the gallant gentleman will be able to tell us. The Chasseurs d'Afrique, I suppose, were originally mounted riflemen, although I am afraid that the French have thrown away the valuable quality of riflemen which these soldiers once possessed and have made their chasseurs into cavalry. On the occasion alluded to at Vibray, they seem to have done good service, for twelve of them held in check a whole brigade of cavalry, and no doubt put the gallant lecturer and his companions to much inconvenience. The lecturer gave us an account of how he organized a corps of what I think he describes as "horse marines," and taught the sailors to ride. These are very interesting experiences, and I congratulate him on having got such a corps into good order and having taught them their duties. Sailors, I believe, would make good men to serve in this particular service, because apparently they are not fond of sitting on their horses but only desire to use them for purposes of locomotion. The great thing to aim at is that the horses or the mules or the camels should merely be used to carry the soldiers rapidly from place to place. That is the object and, having once established, as the lecturer has done, the importance of this, I think he has succeeded in his lecture. There are still matters of detail to be considered: we may wish to know whether it is best to make cavalry into mounted riflemen or to promote infantry and turn them into mounted riflemen. My impression is in favour of the latter course, placing the infantry soldier on an animal with strong legs, not caring much what the animal is, provided it has the legs wherewith to carry him rapidly along, and establish him in a position where his Officer can make use of him, placing him at the best point of advantage, where he can lie hid behind a bank with his rifle in front of him and plenty of ammunition by his side, and there use the magnificent weapon which the British soldier is now armed with. It seems to me that the mounted rifleman should never forget that his duty is to look to his rifle more than to his horse. Everybody in this room knows that the breech-loading rifle has altered the tactics of modern warfare and will alter them still further. Further, it has altered the relative importance of one branch of the service with other branches, greatly increasing the importance of the soldier whose business is to carry the rifle. I do not say anything which will detract from the value and importance of other arms of the service, the cavalry and artillery; but we are aware that the number of men who are put *hors de combat* by the branches of the service other than infantry is very small indeed. The information is within our reach, it is to be found in the Intelligence Department, and I believe it is shown that in the Franco-German war 90 or 92 per cent. were put *hors de combat* by infantry, and the remaining 8 per cent. by cavalry and artillery. Nevertheless, these services are very important, and for outpost duty and for such business as is carried on in advance of army corps, cavalry, with mounted infantry, will always be useful. I should like to make one remark with regard to what the lecturer said about the Crimea, and that

fine body of men which he tells us the Emperor Nicholas took such pride in, namely, the dragoons, who were really mounted riflemen, but who, for some reason, came to be neglected. Had such a force been opposed to us in the Crimea, I believe it would have placed us frequently in great difficulty and put us to great inconvenience. You remember, from the middle of September, when we landed, to the middle of October, when we settled on the southern side of Sebastopol, we were much subjected to attacks. During the flank march, we were especially exposed, and if there had been a strong force of dragoon infantry hanging on our flanks, occupying the Mackenzie heights, and in other ways acting in opposition to us, it would have been a great inconvenience to us, would have greatly delayed, though perhaps not altogether prevented, the operations then in hand. It is curious that the Russians have cast their mounted infantry aside, relying probably on the vast hordes of Cossacks which the lecturer has told us are under their command in some of their provinces and beyond our north-west frontier of India. Many politicians and soldiers maintain that the vast distances which separate Russia from our Indian possessions will prevent an attempted invasion, or an interference with our influence in the East; but the gallant lecturer reminds us of the great power of Russia through the vast hordes of Cossacks under the command of the Emperor, 300,000, he says, and all trained to horsemanship and rifle shooting and now being armed with breech-loaders; independent they are in a measure of commissariat, and are able to march great distances, not being stopped by want of roads. Besides these there are other tribes, equal in numbers, all soldiers born and bred, making half a million of men, trained from their youth to exercises and thinking of nothing so much as war. These reflections should cause us some anxiety and should induce us to do all we can to strengthen ourselves by adopting every well-considered military improvement for the protection and for the security of our vast Empire.

Major Parker: I wish to ask what the size of the Hungarian horse is; and whether the Indian tatoo, which runs from 12 to 13½ hands, would be sufficient? Secondly, whether the cavalry that are to be associated with these mounted infantry should be lancers? I am of opinion, with all due deference to others, that the lance is the most powerful weapon for the cavalry, as the bayonet is for the infantry. Thirdly, whether they would not be better adapted to act with machine guns, which no doubt will sooner or later be adopted in all operations, and whether they would not be better than cavalry to mask, cover, and protect those guns?

The Chairman: It hardly seems that the two last questions have reference to the subject we are discussing of mounted infantry.

Major Parker: I thought that as they would not take long to answer, the gallant lecturer would take them into consideration, and it bears upon the question of the Russian advance. Would not the Sikhs, the Punjabees, and the Beluchees be admirable men to try the experiment of mounted infantry upon?

The Chairman: It would be unbecoming if I did not make a few remarks on the paper, considering the interest of the subject. First of all, with regard to mounted infantry. The gallant lecturer seemed to think that it would be advantageous to associate cavalry and horse artillery with the mounted infantry. Where mounted infantry are employed in large bodies, such as he tells us are already formed under the Russian Government, I have no doubt it would be a very great advantage, and also in such cases as those he mentions in the American war; but with the small force of mounted infantry which England, as a rule, puts into the field for campaigns, like the late one in South Africa, I cannot help thinking that the employment of horse artillery would very much tend to hamper their movements. There is no question about it that in a country like South Africa it would be absolutely impossible for horse artillery to follow the mounted infantry. I think the gallant lecturer will bear me out that it would be so across such a country, with its deep dongas and difficult ground. I am perfectly aware that horse artillery can go almost anywhere where mounted men can go, at the same time I think it would hamper and delay them, and there would be practically little or no advantage in employing them. It must be understood that when used against savage tribes, horse artillery, or artillery of any description, always tends to keep them at a distance. Now with savage tribes you do not want that; you are anxious that they should come near and afford a good target for the weapons which the

mounted infantry will possess. That, I believe, was fully recognised in Algeria when Marshal Bugeaud was first employed there as Commander-in-Chief. He found that the French force had invariably been going out with artillery and consequently the result was very small indeed. The first expedition he sent out, he started without artillery. The Officers, whom he spoke very frankly to, came to him at once to remonstrate, and said, "When we had artillery, it was with the greatest "difficulty we could keep the enemy at a distance from us; and what shall we do if "we have no artillery?" He very justly remarked, "I know perfectly well if they "come down, you will be able to give a good account of them; we do not want them "far away, but near, so that you may be able to show exactly what you are made "of." On that account, I would certainly deprecate any employment of artillery with Mounted Infantry, except when they are in large masses and intended, as in European campaigns, to produce great results. As regards the armament of Mounted Infantry, which is also an important point, I entirely agree with the lecturer that they should not have a sword, and I do not think they should have revolvers. I believe that in pursuit, which is the only time when the "*arme blanche*" would be used by Mounted Infantry, the sword, unless employed as a pike, is of very little use, and the natural instinct of a man unless trained to the use of a sword is to employ it for cutting. The revolver, I believe, would be quite as dangerous to the party pursuing as to the pursued. But I believe it is absolutely necessary that the Mounted Infantry should have some means of making a successful pursuit, and that was distinctly recognised in the campaign in South Africa. Major Barrow, who has taken the greatest interest in the Mounted Infantry, was so impressed with this that he got them swords, and at the battle of Ginghilovo they were used with a certain amount of effect; but at Kambula, after the action, Colonel Buller and his men could only act in pursuit by loading on horseback and firing to the best of their ability, which did not produce the same result as if they had had some kind of *arme blanche*. I think it would be advisable that they should have what the lecturer advocates, either a sword-bayonet or, what would be better still, because it would make the rifle less top-heavy, a long light bayonet. It could be used with very great effect in the pursuit simply as a substitute for a lance. I will now ask the gallant lecturer to make any observations on what has fallen from those who have favoured us with their remarks.

Captain LUMLEY: In reply to Major Parker, I would say that the Hungarian horse is between 14 and 15 hands. Everybody is prejudiced in favour of his own weapon. I was a lancer. I think the lance the best, and if I had anything to say to it I should advocate it. I was very young when I left India; therefore I could not express an opinion on the Indian horse; but I have been told by people who have been in India, that there are plenty of horses there that would suit this purpose very well. With regard to the natives, if the Russians can make use of them, no doubt we can do the same, but I cannot say whether the natives mentioned by Major Parker would be suitable, although I believe they would be. There are people acquainted with India who understand that better than I do, and whose opinion, if this idea is carried out, would be of greater value than any I can venture to express.

The CHAIRMAN: It is now my pleasing duty to ask you to pass a vote of thanks to the lecturer for his very interesting and able lecture. As you all know, it is a subject that cannot be too much thought of and fully discussed, and we are extremely indebted to Captain Lumley for having come forward and given us such a lecture.

Monday Evening, March 21, 1881.

ADMIRAL SIR GEORGE ELLIOT, K.C.B., in the Chair.

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## ON A NEW SYSTEM OF HYDRAULIC PROPULSION.

By Vice-Admiral J. H. SELWYN.

THE subject to which I am about to draw your attention is one of considerable interest, not only on account of its connection with hydraulic propulsion, but as leading to the study of a hitherto neglected branch of hydrodynamics, which may even influence, when thoroughly understood, some of the accepted physical theories.

We are all more or less familiar with the various forms in which machines for utilizing water-power have been made. In useful effect produced, no doubt the turbine stands at the head of the list, and the attempts hitherto made to apply hydraulic propulsion to vessels have almost invariably comprised some form of turbine, to which the power of the engine was applied, in order to obtain a reactive effect from water set in motion. But in every one of these systems, not excluding the most modern form of centrifugal pump, the methods employed were such as to produce the following effects :—

First, the water was set in motion by discs, fans, vanes, paddles, or screws, inside a casing, which confined it, so as to produce a pressure.

Next, the water under such pressure was caused to take a determinate direction.

Lastly, a controllable ultimate direction was imparted to the water, which might be forward, backward, or opposite on the two sides, or, again, entirely annulled by being converted into upward pressure, at the will of the operator, and without interfering with the movement of the engines.

It was, in fact, the realization of a most perfect form of propulsion, which, being entirely based on reactive effect, was not, and could not be, dependent, like the paddle and screw, on the steadiness of the vessel for its maximum useful effect, besides presenting many other advantages which have been often brought to the notice of this Institution, and which it would be out of place to bring forward again on this occasion.

But there have been also objections made to the use of hydraulic propulsion, and these have been invariably on the score of lower speed obtained with a given I.H.P., since nothing else could have been adduced against a system which on all other points showed so unmistakable a superiority. No impartial observer will allow, if he is fully

in possession of the facts, that any such defect in speed has been shown, but the objection still has great weight with large numbers of persons, who ought to be better informed on a matter so nearly affecting the maritime interests of Great Britain.

But we will, if you please, for a moment consider what the objection would amount to, were it absolutely true. More I.H.P., and therefore more fuel, must be used; but this would be all, and with more economical modes of burning fuel and less of the "baseless superstitions of the profession" (as a great American engineering authority has called them) as to the pressure at which we use steam, this increase of fuel expenditure might be nullified. Would this be the case with the paddle and the screw? Clearly the question must be answered in the negative, for both being dependent on the area of water against which they push for their reactive effect, and this area being limited constantly by the draught of water of the vessel to which they are applied, and occasionally by her movements in pitching and rolling, can never be equally efficient with the internal reactive effect produced by a properly constructed hydraulic propeller. The problem involved in the construction of such an instrument is much more complex than would at first sight appear probable, and we shall find that one of the first conditions of success is, that all change in the direction of the water when set in motion by the machine, which is not necessary for our purposes, is to be sedulously avoided. Next, that all lifting of a column of water detracts from the propulsive effect, since whatever power is absorbed for this purpose is taken from that which is available for setting the water in motion in a direction contrary to the path of the vessel, and it is from this source that we expect our forward motion. Thus the water ought to be taken into the vessel when moving with the least possible effort, and leave it with the least possible shock.

Theoretically, therefore, the water should enter the bottom of the vessel by its own gravity, should ascend an inclined tube forming part of the vertically disposed propeller casing, and having had motion imparted to it by the propeller, should leave the vessel immediately above water, with the velocity and area necessary to overcome the resistance of the vessel, and to give her the desired speed. But there should be no whirling or vortex action of the water, and no changes of cross-sections or bends in the tube, since all these tend to diminish the ultimate velocity with which the water leaves the vessel, and $v$ being velocity in feet per second, pressure in pounds on the square foot is $v^2 \times \cdot 976$, but little less than the square of the velocity itself.

In the "Waterwitch" I find—

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|---|---|
| Area of orifices of discharge...... | 6 square feet, |
| Velocity of water of discharge.... | 30 feet per second, |

and by the foregoing formula, 878·4 lbs. per square foot, which gives for 6 square feet 5,268 lbs.

Now it may fairly be said that all those hydraulic propellers we have hitherto seen applied, have the features, which I have referred to as being theoretically objectionable, very strongly developed. They

do interrupt the motion, they do create vortices, and they have contractions and bends in the channels of the water. They also develop a pressure in the casing, due to these circumstances, which, though it may be, nay is, indispensable in a pump or a revolution indicator like Mr. Tower's,[1] is positively to be avoided in a propeller.

Yet, in spite of all these defects, the hydraulic propeller has given a speed of vessel equal to that of the screw, under, as nearly as possible, similar conditions.

It is also to be remarked, that it has never yet been tried under those conditions of high velocity which would be most favourable to its action and most fatal to that of the screw, unless we are to admit unlimited draught of water or a reduplication, which I should consider most objectionable, if the effect we seek can be got without it.

Having thus glanced at the merits and defects of known systems of propulsion, I propose to bring before you the invention of Mr. George Wilson, C.E., who is the author of papers on the "Flow "of Gaseous Substances into each other at High Pressures," and who has in Holland had extensive experience in the use of Gwynne's and other centrifugal pumps.

I said at the commencement that I was about to refer to a neglected branch of hydrodynamics. It is this:—That water (indeed every fluid or gaseous body) adheres to solids with a force proportioned to the square of the velocity with which the solid passes through it. Now, there are many familiar instances in which this effect is seen. If a grindstone be driven fast in a trough filled with water, not only is the water centrifugally dispersed, but a film of water will be seen ascending higher and growing thicker on the periphery as the speed is increased. If a fly-wheel pit be filled with water the rim of the wheel, though turned smooth, and more, the smoother it is, will instantly do as the grindstone did. If, again, a circular saw be drowned in water, it will empty its own pit. A ship also carries, as we know, a skin of water with her. Neither has the principle been left without its application in pumps, for Messrs. Gwynne's pumps have been most successful since the internal wheel took the shape of a disk, on which the blades of the former turbine remain only as mere adjuncts. In propellers, too, Mr. Aston's paddle-wheels, which had no paddles, but only rims, are an application of the same principle.

But none of these are capable of perfectly fulfilling the conditions which ought to be obtained for the propulsion of vessels with convenience and economy, the rim paddle because of the position and size, the centrifugal pump because it creates a vortex, and all modifications of paddles revolving in cases because they create counter-currents which impede instead of assisting the motion of the water in a determinate direction.

You will, perhaps, be surprised to hear that a common grooved pulley, differing from the sheave of a block only in size and shape of groove, has been found capable of doing what is wanted without any of these impediments, and that the smoother the pulley, the better the effect produced.

[1] See Journal, vol. xxiv, page 207 *et seq.*

The size of pulley, or diameter, is dependent upon the circumstances of the particular vessel that has to be moved, and the velocity with which it is sought to move her; but it may generally be said, that in light draught vessels a small wheel with a high velocity will be found most convenient, and in deep draught vessels a large wheel with less speed of piston; and this suits well with other requirements, since, while we have been able to drive small engines at very high speeds, it is difficult, *with any reciprocating system of engine*, to obtain high velocity without serious strains, when great weights are employed.

To give some practical idea of the machine proposed, we will take two types of vessel, one of light, the other of deep draught, and show the calculation. "A" is a vessel whose draught of water is 4 feet, her mid section 80 square feet, and her wetted surface 2,000 square feet.

The diameter of each of two pulleys, applied on the main shaft of engine (which is fixed transversely, and has a speed of 300 revolutions per minute), is 4 feet 6 inches, therefore roughly the circumference is 13 feet 6 inches. This pulley is 30 inches wide, and has in it a parabolic groove 15 inches deep. Half of this depth has to be deducted to arrive at the mean active periphery. The pulley will therefore be calculated as being 3 feet 3 inches in diameter, and 9·9 in circumference: $9{\cdot}75 \times 300 = 2{,}925$ feet per minute, about 48 feet per second.

The "Waterwitch" attained a speed of 9 knots or 15·21 feet per second, with a velocity of 30 feet per second, and the effect is known to increase as the square of the velocity, so that if our area is sufficient we ought to get with 48 feet per second a speed of ship of about 14 knots, unless the resistance due to form is greater than in the "Waterwitch." Now, let us see what area we have, and how many pounds pressure on that area.

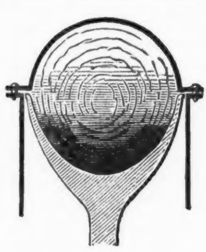
The area of the parabola is two-thirds of that of an equal square. We have here 30 inches $\times$ $15 = 450$, two-thirds of which is 300: area is therefore 300 square inches. As before $v^2 \times {\cdot}976$ is pounds pressure per square foot, and amounts to 2,247 lbs., which, multiplied by 2, the square feet in area, gives 4,494 lbs. as the pressure exerted at each pulley (roughly about 2 tons). We know that with the paddle and screw, from numerous independent experiments and experimenters, the tractive force due to 100 I.H.P. is about 2 tons.

We also know that ·301 of an I.H.P. per square foot of wetted surface will drive an ordinary ironclad 15 knots with twin screw. Further, that 3 I.H.P. per square foot of mid section is a fair allowance for 12 knots. I might say a very full allowance if it be effective horse-power. With these data it becomes easy to calculate what horse-power the engines should exert to drive such a vessel at any given speed, remembering always that with such an instrument as this all increase of power in the engines will constantly be felt as increase of propulsive effort, in the proportion of the squares of the increased velocity.

We will now take the calculation for the deep draught ship, say

22 feet draught, with the usual proportions for a fast vessel in other respects, but limiting ourselves to 70 revolutions of the engines, and a single engine, not two or more, which might evidently be used if preferred. "B," then, will have two pulleys, or wheels, on each side, of which the external diameter will be 20 feet, the groove 3 feet wide, and the depth of groove 18 inches, with 70 revolutions, the velocity will be 59 feet per second, and the speed of ship about 17 knots, if there be sufficient area. The area will be 864 square inches, and the pressure per square foot 3,397 lbs. $\times$ 6 = 20,382 lbs. on each of the two jets. But 20,382 lbs. is only equal to a little over 9 tons, and as with such a ship we should employ about 3,000 I.H.P., each hundred of which would give a pull of 2 tons, or 60 in all, it is clear that the above area will be entirely insufficient for our purpose. We want at least three times as much, or six such pulleys on each side. That is about 18 feet of pulleys in the thickness on each side of the engine, which would be absurd. Now, suppose we can increase the number of revolutions of the engine to 140 without difficulty, and I am disposed to think this might be done, what help should we get in that direction? The velocity would rise to 118 feet per second, and $118^2$ gives 13,924, say 6 tons per square foot. Now we have 6 square feet in each jet and 6 tons pressure per square foot, so we should have 72 tons pressure in all, or more than we require as the result of 3,000 I.H.P. So that there is no insuperable difficulty in the application even in what must be regarded as an extreme case, for if the engines were duplex, as in twin screws, it would be easier to attain the results, and there would be some other advantages gained in the event of one engine breaking down, or where rapid turning power was required.

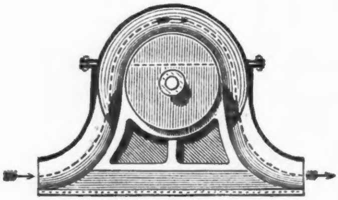
It is also possible to increase the area of groove by making the casing which must always surround the pulleys in a parabolic or circular form, so that the cross-section of any part of the groove will



be parabolic in the groove and semi-circular in the casing, and this will very likely be found to be the most perfect form, particularly at very high velocities, where the water may almost be considered as a rope passing through the vessel, by which she is dragged along, much as a railway engine drags itself and its load along a rail.

Hitherto, I have only spoken of the pulley or wheel, but you will see by the models and drawings, that there is another very im-

portant feature. The water only enters on the wheel and leaves it at the semi-diameter, because this is the limit of the useful motion that can be imparted or communicated. All beyond the semi-diameter, whether the water be conducted over or under the wheel, though useful in a pump, would be dead loss in a propeller. To meet this condition there is introduced a species of diaphragm of peculiar shape and section fitting nearly the lower part of the groove, and having curved surfaces, which form a continuation of the limits of what has been called the "rope of water," which form in fact with the casing a pipe through which that rope of water passes. It will easily be seen that the tendency of water set in motion by any portion of the periphery of a wheel, and prevented from flying off centrifugally, would be to follow the periphery in its circular path, as in the helical pump, the disc pump, and all centrifugal pumps pure and simple. But with the condition of propulsion to fulfil, the energy must be directed in another path, namely, that which is opposite to the progress of the vessel, and in this machine it is done by, so to speak, scraping the water off the wheel, and diverting its motion into the needed curve. In doing this, there must necessarily be a slight loss of power, but it is the least possible, consistently with the effect to be produced. The path of the water is shown by the arrows and



dotted line in No. 2 diagram. Arrangements are made by which the reversal or interruption of the motion can be effected, while the engines continue to exert their full speed ahead something in the same way as in the "Waterwitch."

I have now put before you the shape of the instrument proposed and given you some account of the way in which it does its work theoretically. But this latter would be incomplete, were we not to examine the question of hydrodynamics involved. In Mr. Scott Russell's paper (vol. xxii, No. CII of the Journal of this Institution), are some statements which show very clearly how water is acted on by wind. Here is a case, not of a solid body imparting motion to water confined in a casing, but of water set in motion by the impact of the atmosphere, the direct pressure of which is, according to Mr. Scott Russell:—

| | | | | |
|---|---|---|---|---|
| 1 lb. | for wind at | 20 | miles | per hour. |
| 4 lbs. | " | 40 | " | " |
| 9 lbs. | " | 60 | " | " |

Query, what is the pressure to be added on account of direct weight of atmosphere.

He says also, that 4 lbs., or the sixteenth part of the weight of a cubic foot of salt water, could communicate a velocity of 2 feet per second to 1 foot of water in one second of time.

These statements will serve to show what we might expect from such a pulley as I have been describing, set in motion at such a speed in a body of water. From another paper on "Tower's Revolution "Indicator" (vol. xxiv, No. CV), we find that in that instrument, which is a paddle turbine, raising water in a confined column to a height corresponding to the number of revolutions, the elevation of the column is precisely that due to the number of rotations multiplied by the *external*, not the *mean* circumference of the wheel, and calculated according to the laws of falling bodies. Therefore, even at the comparatively slow speed of 60 or 70 revolutions, we might be sure that the whole of the water is really set in motion, since the atoms must re-act on each other precisely as they do when wave motion is produced by wind, with the remarkable difference, however, that the motion is propagated from the motor outwards, not from the surface inwards, and thus in some measure resembles the wave of translation, which delivers its force through any distance without diminution. It is now necessary that I should tell you what has actually been done in practice. Engineers of high-standing had predicted utter failure. They said that it was absurd to suppose that a smooth pulley could communicate any motion to water. It ought at least to be roughened, if it did not require paddles; this was disproved *in a bucket.* Then "it might move water in that way, but it could never act as a pump;" this was disproved in a tank. Then it could, at least, never answer as a propeller; this has been disproved in a boat. I have not the least doubt that it will now pass into the second phase of inventions. The first is, "the thing is not good;" the second is, "the thing is not "new." After these are disposed of there will, no doubt, come some other phases of the subject, which are principally disguised attempts to appropriate the profits; and I can only say, though I have no other than a scientific interest in the question, that I hope the inventor will get his reward in due time, and not be left to languish like "Screw" Smith, and so many others of our cleverest inventors. At the beginning of this paper I spoke of the subject being an interesting one from purely physical points of view, and I wish briefly to call your attention to this part of the subject: If we admit that the adhesion of water to a solid moving in it is so great that the whole velocity of the moving body can be imparted to it, we shall first see the importance of skin friction in ships, and be able, perhaps, to measure it more accurately. We shall be able to find out the value of the same force acting on the surface of our screws; we shall be led to reconsider the whole problem of pumping engines at high speeds (the account of the work done by a centrifugal pump at Crossness shows the necessity of this), and generally there will be a new light thrown on many most interesting problems in hydrodynamics.

But we may go even farther, I conceive, and examine into the great

forces at work on the globe, either to retain the water of the ocean in its place against the centrifugal force, or to cause the motion of great bodies of water from east to west. What may not be due to a speed of a quarter of a mile per second, if with the petty speed of under 100 feet per second such results in propulsion may be produced. I venture to commend the whole subject to the younger members of the naval profession as one full of interest for them, but there is matter enough for thought in it for engineers and philosophers of the very highest calibre, and by these I hope it will be taken up and thoroughly investigated. I believe we shall find a law prevailing that speed of rotation being a quarter of a mile per second, adhesion is absolute. Finally, I have only to say that when a vessel of about 130 tons now preparing is completed, I shall be happy to give a more complete account of the advantages of this mode of propulsion, combined with the Perkins engines of 200 I.H.P. This I hope to be able to do some time in the autumn of this year.

Captain Curtis, R.N.: There is one point to which I should like to refer, although it does not arise directly out of the paper, and that is a question with respect to the economy of coal. I do not profess to be an engineer, I am merely a retired naval Officer, but I have been impressed with the idea that coal is compressed gas. We have all heard what force it takes to compress oxygen, and we know that coal is a mineral of carbonized wood, and derives its substance from the elements; and I think there is no doubt about it, that coal can be converted into carbonic acid merely by a proper application of oxygen, and there will be only 5 lbs. of ash left in a hundredweight of coal, and there would not be the waste of smoke, unburnt coal, and carbonic oxide discharged up the flue. As Admiral Selwyn says, there are always objections to new inventions because they destroy something old, and it upsets the existing plant; I think that is the great objection to new inventions. I cannot help being struck with the idea that that wheel follows nature's course—that is, the faster anything goes round the more anything will adhere to it; thus the faster that wheel goes round, the more the water will adhere to it. I certainly see in this system a new propeller, and, perhaps, by first making a toy of it for children, people would see the effect of it, and they would think there is something in it.[1]

Mr. Ernest W. Buller: It seems to me that, in taking the centrifugal pump for his basis, the lecturer is making a comparison which is hardly fair, because in a centrifugal pump you use a force with which we have all been accustomed to deal, and which we can depend upon, namely, centrifugal force. The centrifugal pump takes in water at the centre, and drives it out at the circumference, but here we have a propeller which does not do that at all—it is supposed to impart no centrifugal force. As I understand, it is said that if you arrive at a certain velocity there is to be absolutely no centrifugal force, but you are to have an entirely new principle, which is called adhesion. Now, many of our machines are calculated upon the known data and laws that rule centrifugal force—such as governors, centrifugal fans and pumps—and the same principles apply in the simplest cases, as when the washerwoman trundles her mop. I ask at what speed does that centrifugal force, which we know exists up to considerable speeds, tend to diminish or cease altogether, and this new principle of adhesion come in? I think if this machine has so far progressed that it can be calculated and designed, and so on, there ought to be something known as to the conditions under which these old laws cease and this new one comes into operation.

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[1] When I suggest making a small vessel or imitation "sea-horse or fish," and propelling it by this wheel, it will be sooner brought before the public, and they will see there is something in it.—J. D. C.

The CHAIRMAN: It would be necessary, I think, to read this paper most carefully before venturing really to criticize it, for it is impossible to carry in one's head all the details, the figures and results, which have been presented to us to-night. There are, however, one or two points upon which, I presume, the Admiral has offered only an opinion, as he certainly has not been able to afford any proofs. He says in the first place, "If we admit that the adhesion of water to a "solid moving in it is so great that the whole velocity of the moving body can be "imparted to it, we shall first see the importance of skin friction in ships." It may be possible that the movement of this water is partly due to friction, but, to my mind, it is mainly due to a totally different cause. He has not mentioned atmospheric pressure; and, as I do not believe that you can make a vacuum in water, it is evident that if you set water in motion at all by means of this wheel, the atmospheric pressure will cause the stream to follow, so as to prevent a vacuum occurring. However, all engineers who have seen it have, I think, acknowledged that there is something very extraordinary in the fact of this wheel going round and carrying with it a solid body of water. How far that would continue at extreme velocities, I do not know. These matters are in their infancy; we want facts first of all, and therefore I would ask the Admiral what results have been obtained from the trials which have been made. I understand that a boat on the Thames which had been previously driven by a screw propeller has been used to experimentalize with this wheel, the screw being removed, the engines remaining, and the same power thus being exerted on a wheel of this kind to drive the vessel, but I have not heard with what result. I do not think this can be called a new system of propulsion. It is a new propeller we are dealing with, but it is the same system of hydraulic propulsion as has existed in vessels that have already been tried, such as the "Nautilus" and the "Waterwitch." It is a new form of propeller, and this new form of propeller has been tried in this boat, and as they know that with the screw they obtained with that boat eight-knot speed, I should like the Admiral to let us know what the actual result has been with this turbine, the boat being at the same draught of water, and the same power being exerted. This information would certainly afford some sort of direct evidence as to the efficacy of this new turbine as compared with the old. I regret extremely that the hydraulic system of propulsion has met with so little encouragement. It is a subject of the greatest possible interest, and I addressed a very urgent letter a year ago to the Lords Commissioners of the Admiralty, asking for a progressive trial of the turbine, the result of which letter has not been what I hoped, viz., a progressive trial, as they have only decided to apply hydraulic propulsion in a torpedo-boat. Now I am not here to blame the Admiralty, for I am aware that whenever the year comes round, and they have to decide how the money of the country is to be spent for building purposes, it is only natural that the Constructors should desire to secure a given speed for their war-vessels, and therefore they dislike experiments. You have only to look at the records of the debates in the House of Commons to see how anxious each Board of Admiralty is to show the country that they are more clever than their predecessors as regards the mode of expenditure of the annual vote for shipbuilding. If they decided to build a vessel of a considerable size with hydraulic propulsion, the Admiralty would turn to the Constructors and say, "Will you guarantee the speed?" The Constructors say, "No, we cannot do that; we know exactly what has been reached with the hydraulic "propeller in a small vessel, but we are not prepared to guarantee in a bigger vessel "the same speed that we know has been and can be obtained with the screw." I do not say they are right. I believe that, having a vessel like the "Waterwitch" before them, knowing her lines, her displacement, the power exerted, and the speed obtained, a builder ought to be able to guarantee a certain speed with greater power in a larger vessel. I think that there is not much risk, but still the Constructors do not choose to guarantee the speed, and the consequence is that no progress has been made in developing the system of hydraulic propulsion since the year 1866, now fourteen years ago. I am perfectly convinced that whenever the system of hydraulic propulsion reaches maturity, better results of speed will be obtained for a given power exerted than has hitherto been reached by the screw or paddle, and my opinion is based on the facts already before us, which cannot be disputed. It is only, too, extraordinary that, looking to the dangers inherent in screw propulsion,

and the greater safety to navigation, and other manifest advantages to fighting efficiency, which are offered by the adoption of the turbine as a propeller, this feature of the science of naval architecture has been so carelessly treated; but this anomaly is only to be explained by the circumstance that any new mode of propulsion must be prejudicial to vested interests, which are all-powerful in self-defence. I am afraid I am taking up your time with the general question of hydraulic propulsion rather than this invention, but I should be very sorry to offer any remarks upon this new turbine, because I do not think I should be prepared at present to do so. I think it certainly shows some very curious features of the law of hydraulics, and it may turn out very successful, but I am not prepared to question the figures or the statements of the Admiral. I believe that hydraulic propulsion would long ago have been carried out, had there been only money at the back of it to make a fair and proper trial of it, and that has never yet been the case. I have tried on several occasions, and directly it came to the point of building the vessel the builder was obliged immediately to put a very much increased price on his vessel. The late Baroness Rothschild could not stand the vibration of the screw in her yacht, and she decided, at my suggestion, to try the hydraulic propeller; but the moment I went to the builder, he said he must charge 6,000*l.* more for his vessel. Why? Because everything must be new. If you want a screw engine, a builder has everything at his hand; but if you want to put in the hydraulic he does not know anything about it, and, being a novelty, he immediately claps on a large price; consequently that is the great stumbling-block in the way of getting this tried in the commercial marine. On the 27th March, 1867, after the trials of the "Waterwitch," the Controller of the Navy, Sir Spencer Robinson, commenced a letter to me as follows:—"Sir,—The success that has attended the hydraulic engine in the 'Water-" 'witch,' as fitted under your direction and Mr. Ruthven's arrangements, appears to me to warrant *further trial* in a vessel designed for greater speed, &c." If Sir Spencer Robinson had remained longer in office he would probably have carried out his intention. Then Mr. Andrew Murray, the Engineer-in-Chief of the Admiralty, who attended all the trials of the "Nautilus" and "Waterwitch," wrote as follows:—"From the result of experiments made under my supervision in 1867, as " demonstrated by the official reports of trials of the 'Waterwitch,' I look upon the " turbine as no longer an experimental propeller, but as one whose performances are " established facts placed beyond question or dispute. I hold it proved that the " turbine, when properly constructed and properly applied, will be nearly equal to " the screw as a propeller in smooth water (without reckoning on further improve- " ments, which are sure to develop themselves by experience), and I look upon it as " almost a certainty that it will prove superior in a seaway when applied to a sea- " going ship." I quote these authoritative reports to show that, although this system of propulsion has been lying dormant for so many years owing to official supineness, there is no reason in the world why any one who has the power or who has the means at hand should not feel confident in investing money in this mode of propulsion. I am very glad that Mr. Thornycroft is going to build the torpedo-boat, because we all know his talent, and that out of it some good may come. He will see what speed he gets with his boat with the turbine; he will be able to compare that result with what would have been the speed he would have got with the screw in the same boat if the screw had been in its normal position. But, unfortunately, there can be no competitive trial, because in these torpedo-boats the screw is not in its normal position; the screw-shaft is on the keel, and therefore the screw-blade comes half below the keel, and by this means you get a large diameter of screw. In an ordinary sea-going vessel it would not be practicable to put your screw in that position. The progressive trial that is wanted is in a vessel bigger than the "Waterwitch," and of greater speed; and if ever the day comes that we do get a sea-going vessel of that kind, I believe that the result will be so favourable in all respects that that system of propulsion will come into general use. In order to show that improvements may be expected to arise out of further development I would mention this. There was a small alteration made in the entrance of the water into the turbine of the "Waterwitch" at Portsmouth. The canal was closed up, and a round hole cut underneath the turbine and a tube put in it, and half a knot of extra speed was obtained by this means. If the turbine had been lower down it would

have been actually working in the sea, and I believe would have produced better results.

Admiral SELWYN, in reply, said: Captain Curtis referred to the compression of gas until it takes the shape of coal. We all know that that is the case, and I think perhaps very few have devoted more attention to the subject of condensed fuel than I have. Condensed fuel is the nearest approach to gas. We cannot carry gas, but we can carry oil, and oil which is not dangerous to deal with. In the course of experiments I have put white hot bricks into the oil, and I could not by any means induce fire on the surface. Nothing short of shavings, or some sort of wicks, distributed over the surface would produce any ignition at all, and then it was a smoky ignition like that of train oil. This condensed fuel is being used in Russia on the Caspian. The fact is, I have had the misfortune of seeing my work thrown aside by this nation and taken up by Russians. I hope, however, that will not continue to be the case after I have demonstrated its value by means of a yacht which we hope soon to launch. Captain Curtis also refers to the marvellous result of only 5 lbs. of ash being left after the ignition of a hundredweight of coal. Would he be very much surprised to hear that on Saturday last the "Anthracite" went down the river and burnt during some eleven hours of work 2,100 lbs. of coal and only produced 13 lbs. of ash?

Captain CURTIS: How much smoke?

Admiral SELWYN: Not any. She burnt 1·75 lbs. of coal (in an engine of 70 indicated horse-power) per horse-power per hour, and I think she ran something like two hours with nothing but ashes. I think those results are abnormal, and certainly far superior to anything like 5 lbs. of ash to 1 cwt. of coal. Captain Curtis referred to this wheel as a toy. It has passed beyond the limits of a toy, and I shall hope to show you, as I told you, a vessel propelled by its means. I think it deserves more study than any toy could do, though I have seen many toys pave the way for important improvements in mechanics. Mr. Buller asked me how the speed is limited. It is limited at present by the velocity at which we dare drive our engines. As you will easily see, the tendency of those curves of water round the wheel is invariably to take the form of perfect adherence, and as you revolve the body in water, the water thrown off decreases if the supply be the same, and the volume carried round increases with the velocity and as the square of the velocity. I cannot give an engineer anything better than that. If you increase your velocity the adherence of the water will increase as the square of the velocity, that is to say, the volume of water carried round, and the centrifugal effect will diminish. An experiment was tried the other day in this way. A fly-wheel making 90 revolutions a minute with an 8 feet diameter had a little water poured on to its circumference. It carried the whole of that water round without any centrifugal effect, *i.e.*, none of the water flew off: but the instant the quantity of water was increased and became greater than that velocity could carry round, then some was thrown off centrifugally. I have taken the speed of the earth: one mile in four seconds must be admitted to be a velocity we have never thought out in feet per second, and at that velocity I believe the adhesion is absolute for the ocean depth or thickness. This is taking it into the range of pure theory and beyond any evidence that I can give you except what you have heard. With regard to the clothes dryer—a very effective machine used in America—if you take a body, like clothes or sugar, you get practically so many paddles which diminish the velocity of rotation inside the vessel, and force the whole water contained into radial lines so that it must all fly out, and the clothes dryer acts on that principle. If you put only water inside you would find it was not thrown off, but was carried round. The two conditions are absolutely different. The Chairman remarks that I have said, "If we admit the velocity is communicated." There is not a single turbine in the world that does not communicate velocity, for, if it did not, it would not be an active machine at all. They all do communicate velocity. We must admit it because we have seen it, and we are obliged to confess it. What occurs in the "Waterwitch?" You have a velocity of turbine of 29 feet per second, and an aperture very much diminished, it is true. After passing through certain curves, which I daresay Mr. Ruthven might not have preferred if he had been allowed to make the vessel entirely according to his own idea, that water does fly out at that

same velocity; and if we were to examine all the contractions and expansions of those areas, we should have exactly the velocity at which it ought to fly out, considering the velocity imparted to it. Whatever may be the velocity with which the water rotates and leaves any aperture, you will find only half that speed is to be expected as advance or progress in the vessel, and this becomes perfectly obvious when we consider the question of the screw. Supposing we say to a man, "Here is "a screw which rotates 80 revolutions per minute and has a pitch of 8 feet, what "will be the velocity of the water leaving that screw?" A great many people will say, without thinking much about it, "Oh! 8 times 8 is 64—640 feet." But that would be utterly wrong, because they have not considered the forward motion of the vessel imparted by the reactive effect, and that this must be added to the velocity. The same law holds good, not only in the screw, but in all other propelling instruments—a certain loss of effect takes place in them by driving the atoms of water in the wrong direction; and we claim that in this no such action takes place, that in this every impulse communicated to an atom of water is useful effect in velocity, and that the faster you drive it, the better effect you will get, up to any velocity you please; but you will have to observe in calculating your horse-power, very closely, first, what the effect of the indicated horse-power can be expected to be in foot pounds; and when you get that out and calculate the area and velocity, you will not make an error in putting in your turbine, that is, if you have carefully calculated the velocity and rotation as that of the wheel itself; for, as far as we know at present, there is no difference between the velocity of the water and that of the wheel. There is a great difference between the velocity of the water and that of the vessel; that is quite another thing. That might be called "slip," if you like: but I should rather call it reaction. Given a certain velocity per second, and pressure in foot pounds will be nearly the square of the velocity. A suggestion has been made this evening by a gentleman who has thought about the subject and is deeply interested in it—a man who thinks a great deal and a great many times over these subjects before he says anything. He says in order to make that thing perfect we ought to have a power of contracting those apertures and expanding them at will; because, when the engine is going slowly, it is clear that though the area may remain the same, the velocity imparted is not sufficient to drive the vessel; but if we keep up the velocity by contracting the area so as to bring it proportionately to the effect of the wheel, then we shall get a certain velocity at slow speed. Perfectly true; but it is a very difficult thing to do. I am sorry to say there are an immense number of gentlemen whom I have known during a long life connected with various subjects, who always want experiments tried on the scale of 12 inches to a foot, and then they prophesy; but these are not gentlemen with whom it is much worth while to argue a question of this kind. What we want is to rub brains together in order to get out results. What we do not want is to convince the gentleman who says, "When I have seen I shall have faith." As regards the increased price for new machines, I am happy to say I find no great difficulty on that score. I go in for designing a vessel, specifying everything down to a brush; and I find I can get a very reasonable price without any difficulty whatever. I do not ask the builder to take the responsibility of the engines or propellers, about which he knows nothing and cannot be expected to know. The Chairman asks me to define what has been done with this propeller in a boat. I will tell you what has been done. Exactly the result has been obtained in that boat which was due to the efficiency of the instrument put into her. She gave the number of revolutions which her engines could give with that size of machine; and out of the 9 feet per second velocity which she obtained as velocity of water, she gave 4½ feet per second as progress through the water.

The CHAIRMAN: We know that she went 8 knots with the screw; at what rate did she go with this propeller?

Admiral SELWYN: When she went 8 knots with the screw she made 250 revolutions of her engines. If she could not get these revolutions the engines could not indicate the power. If you put a donkey into a drag, you will bring up the donkey; you must put four horses into the drag, and then the drag will go. It is no use talking about what she went or what she did not go. She went what she ought to have done according to the ordinary law.

Mr. Griffiths: What was the relative power as compared with the screw?

Admiral Selwyn: If she had had a proper sized machine in her she would have gone faster than with the screw. She did go exactly according to the number of revolutions made.

The Chairman: With regard to that question I was informed that this trial was going to be made in this boat, and that then we should see what the result would be. I am very glad that any trial should be made with regard to hydraulic propulsion, if it is anticipated that the trial will result in any information as regards speed. We were told that the boat went 8 knots with the screw, that the engines were to remain, and they were simply to alter the propeller, and so on. I asked at what rate did she go, and I cannot get a distinct answer.

Admiral Selwyn: She went 4½ feet per second. She did go exactly the same as the "Waterwitch." It would be rather more than 2½ knots, that is to say, she went exactly what we expected her to do with those revolutions. If I were to put a propeller of 20 feet diameter with an engine of 25 horse-power, do you think she would indicate 25 horse-power? Nothing of the kind. The result is, I am perfectly satisfied, that we shall get in the yacht properly proportioned with a view to the machine and the horse-power to be exerted, a little beyond what anybody else could get with the screw in 4 feet draught of water and 80 feet midship section. I have only to draw attention to the fact that this is a new thing altogether, that it does not depend on friction in any sort of way; and if experiments show that what I have been stating is correct, I think there is not an engineer here present who will not thoroughly understand that he has got a new propeller totally different from anything he has seen before.

The Chairman: I think the Admiral has not gone the right way to work to invite discussion by the remarks he has made, because when first hydraulic propulsion was introduced at the Society of Engineers, it was prophesied by clever engineers—and I believe Brunel was one of them—that they would get little or no speed out of the turbine. Another engineer prophesied a loss of 50 per cent., and I believe Mr. Scott Russell was the only man who approached to 25 per cent. of loss. The result proved to be very different from all those prophecies; therefore I say I am justified in being sceptical. I shall be very glad to see any improvement introduced into hydraulic propulsion; and if this new turbine turns out to be a better turbine than the other, the gentlemen who have introduced it will have conferred a great benefit upon navigation as well as upon science. But when we come to discuss these points, the way to arrive at information is by challenging certain points—in fact, endeavouring to pick as many holes as you can in it, and you will then get answers which will enable you to arrive at some conclusion. If the Admiral can get four or five knots more out of this new propeller than was obtained out of the old turbine it will be a splendid invention, and there will be no longer any question as to the value of hydraulic propulsion. I am sure you will allow me to return a vote of thanks, in your name, to Admiral Selwyn for his interesting paper.

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# OCCASIONAL PAPERS.

This portion of the Number is reserved for Articles, either Original or Compiled, on Professional Subjects connected with Foreign Naval and Military matters; also for Notices of Professional Books, either Foreign or English.

It is requested that communications or books for review may be addressed to Lieut.-Colonel Lonsdale Hale, at the Royal United Service Institution, Whitehall Yard, London, S.W.

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## A STUDY OF OPERATIONS IN THE POLISH THEATRE OF WAR.

Extracted from "Der Polnische Kriegsschauplatz. Militär-Geographische "Studie." Von "Sarmaticus." Hanover, 1880. Translated by Captain Rothwell, D.A.Q.M.G., Intelligence Branch.

Note.—In No. CIV, vol. xxiv of the Journal, there is a paper, written by Sir Lumley Graham, Bart., on the "Russo-German Frontier of 1880." That paper and the following paper supplement each other, and together form an exhaustive treatise on a part of Europe which, in the present state of unstable political equilibrium, may at any time become the scene of a gigantic struggle. —L. A. H.

The available troops of the three great Eastern Powers must in the first instance be shortly enumerated, and a statement given of their distribution, as this has an important bearing on a concentration on the frontiers.

1. *Germany.*—The Army of the German Empire consists of eighteen army corps = thirty-seven infantry divisions. Of the cavalry divisions only three are formed in peace time, the remainder being brought together on mobilization, from ten to fourteen being formed, according to the strength which is given them. The distribution of the German Army is considered as known.[1]

2. *Austria.*—The Austro-Hungarian Army has in peace no army corps organization, but is composed of thirty-six infantry divisions. The twenty-one cavalry brigades are distributed among these, as larger units of cavalry are only formed on mobilization. The distribution in time of peace is as follows:—

[1] This distribution is as follows:—

| | | | |
|---|---|---|---|
| Guard. | Berlin. | | |
| I. | Königsberg. | X. | Hanover. |
| II. | Stettin. | XI. | Cassel. |
| III. | Berlin. | XII. | Dresden. |
| IV. | Magdeburg. | XIII. | Stuttgard. |
| V. | Posen. | XIV. | Karlsruhe. |
| VI. | Breslau. | XV. | Strasburg. |
| VII. | Munster. | I Bavarian. | Munich. |
| VIII. | Coblentz. | II Bavarian. | Wurzburg.—Tr. |
| IX. | Hamburg. | | |

| | | | | | |
|---|---|---|---|---|---|
| I | Inf. Div., | Sarajewo. | XIX | Inf. Div., | Pilsen. |
| II | „ | Vienna. | XX | „ | Essegg. |
| III | „ | Linz. | The XXI, XXII, and XXIII Inf. Divs. are only formed on mobilization. | | |
| IV | „ | Brünn. | | | |
| V | „ | Olmütz. | XXIV | Inf. Div., | Lemberg. |
| VI | „ | Gratz. | XXV | „ | Vienna. |
| VII | „ | Trieste. | XXVI | „ | is formed on mobilization. |
| VIII | „ | Innsbruck. | | | |
| IX | „ | Prague. | XXVII | „ | Cracow. |
| X | „ | Josefstadt. | XXVIII | „ | Agram. |
| XI | „ | Lemberg. | XXIX | „ | Theresienstadt. |
| XII | „ | Cracow. | XXX | „ | Lemberg. |
| XIII | „ | Dolnje Tuzla. | XXXI | „ | Buda-Pesth. |
| XIV | „ | Pressburg. | XXXII | „ | Buda-Pesth. |
| XV | „ | Kaschau. | XXXIII | „ | Comorn. |
| XVI | „ | Hermannstadt. | XXXIV | „ | Temesvar. |
| XVII | „ | Grosswardein. | XXXV | „ | Klausenburg. |
| XVIII | „ | Mostar. | XXXVI | „ | Banjaluka. |

If we consider these forces and their distribution with reference to an eventual entry into the Polish theatre of war, those divisions must first be subtracted which, by reason of political circumstances, are bound to the provinces which they occupy, and could hardly be employed in any other district. These are the I, XIII, XVIII, and XXXVI Infantry Divisions, which are stationed in Bosnia and Herzegovina, and the VI, VII, and VIII Infantry Divisions, which, at Gratz, Trieste, and Innsbruck, stand facing towards Italy.

There remain then twenty-nine divisions for disposal, of which, however, four are formed only on mobilization. Since, according to the Austrian system, one army corps is composed of three infantry divisions, eight army corps might be brought into the first line in Galicia, and five divisions could arrive soon afterwards.

We do not know the intentions of the Austrian Headquarters, but there is no difficulty in arranging the divisions in army corps so that they may be able to use in common one of the four lines of railway leading to Galicia; for example:—

1 corps (II, III, XXV Divisions) Vienna and Linz.
2 „ (IX, X, XXIX Divisions) Prague, Josefstadt, Theresienstadt.
3 „ (XIV, XV, XXXIII Divisions) Pressburg, Kaschau, Comorn.
4 „ (XVI, XVII, XX Divisions) Hermannstadt, Grosswardein, Essegg.
5 „ (V, XII, XXVII Divisions) Olmütz, Cracow.
6 „ (XI, XXIV, XXX Divisions) Lemberg.
7 „ (IV, XIX, XXVIII Divisions) Brünn, Pilsen, Agram.
8 „ (XXXI, XXXII, XXXIV Divisions) Buda-Pesth and Temesvar.

The remaining division, the XXXV, at Klausenburg, would be eventually moved by route march into Bukowina either for the protection of this province or in order to be sent forward from there by rail to Lemberg.

3. *Russia.*—The European army of Russia, leaving the Caucasian troops out of consideration, consists now of seventeen army corps, each composed of two or three infantry divisions and one cavalry division, the latter bearing the same number as the army corps to which it belongs. Those corps which have three divisions are specially noted. The peace distribution of these troops is as follows:—

| | | | | | |
|---|---|---|---|---|---|
| Guard Corps | .... | Petersburg | .... | Guard Cav. Div., | Petersburg. |
| I Army Corps | (3 div.), | Petersburg | .... | 1 Cav. Div. | Tver. |
| II „ | (3 div.), | Wilna | .... | 2 „ | Suwalki. |

| | | | | |
|---|---|---|---|---|
| III Army Corps | | Riga | .... 3 Cav. Div. | Kovno. |
| IV „ | | Minsk | .... 4 „ | Bialystok. |
| V „ | | Warsaw | .... 5 „ | Wraclawek. |
| VI „ | (3 div.), | Warsaw | .... 6 „ | Lomza. |
| VII „ | | Sevastopol | .... 7 „ | Elisavetgrad. |
| VIII „ | | Odessa | .... 8 „ | Kischineff. |
| IX „ | | Orël [Orjol] | .... 9 „ | Romny.[1] |
| X „ | | Charkov | .... 10 „ | Tschugujew.[2] |
| XI „ | | Jitomir | .... 11 „ | Dubno. |
| XII „ | | Kiev | .... 12 „ | Kiev. |
| XIII „ | (3 div.), | Moscow | .... 13 „ | Riäsan. |
| XIV „ | | Lublin | .... 14 „ | Czenstochan. |
| XV „ | | Kasan. | .... Don Cossack Div., | Zamosc. |
| Grenadier Corps | (3 div.), | Moscow. | | |

From this enumeration it follows that six army corps (II, III, V, VI, XIV, and XI) are in the immediate neighbourhood of the German and Austrian frontiers, and that eight cavalry divisions (viz., the 4th and Don Cossack Divisions, in addition to those of the army corps just mentioned) are placed directly in positions to cross the frontier line.

Behind these, nine additional army corps (the Guards, I, IV, VIII, IX, X, XII, XIII, and the Grenadier Corps) might be brought forward proportionately rapidly by rail.

Of the two remaining (the VII and XV) it may be assumed that the first will be kept to garrison the shores of the Black Sea, and that the second, as its mobilization as well as its march westwards, as far as Nijni Novgorod, has to be accomplished without the aid of a railway, must at all events be very late in arriving at the western frontier.

After this glance at the different armed strengths, it is only necessary, in addition, to give an account of the mobilization and the strategic movements by rail of the three armies.

*Germany.*—The mobilization of the German Army in the summer of 1870, notwithstanding the fact that it found the authorities entirely unprepared and taken by surprise, was executed with astonishing rapidity and completeness. The experiences then gained have since been utilized, and the combined mobilization operations considerably simplified and expedited. The preparatory calculations for the railway transport of great masses of troops have been worked out with the most scrupulous exactness, and the large amount which has been done towards the completion of the network of railways in the frontier provinces, within the last ten years, has greatly facilitated the transport of troops to the eastern frontiers of Germany.

*Austria.*—The Austro-Hungarian Army has not, in its present formation, as yet had an opportunity of carrying out a general mobilization. But the partial mobilization in the summer of 1878 for the Bosnian Campaign passed off smoothly, and the experiences here gained offer a guarantee for the prompt execution of the same measures in the whole Army. Much attention has been paid to the movement by rail of large bodies of troops, and in the manœuvres this has been the object of particular exercises and special studies. The working of the Hungarian railways for the movement of the troops to the Bosnian frontier in 1878 was quite satisfactory, although this was carried on along with the normal peace traffic. Regarding the formation of the railway network of Upper Hungary, Moravia, and Galicia, it may be assumed that a collection of the Austrian troops from the two portions of the Empire on the Galicia-Polish frontier will go forward rapidly and without difficulty.

*Russia.*—The circumstances in Russia are not so favourable. There the

[1] In the northern part of the Government of Poltava.
[2] East of Charkov ,on the Donetz.

mobilization of the Army is, from the outset, impeded by the great distances which the men called up have to travel from their homes to the railway, and to join their own detachments. These distances amount to from three to ten times more than those which have to be considered for the mobilization of the German troops. Men called up in Poland do not join the detachments garrisoned there, but are sent away into the interior of Russia. Conversely corps stationed in Poland obtain their ersatz and reserve men from the Governments of the interior, an arrangement which, in consequence of the great distances (Warsaw to Moscow 170 German miles, 830 English), is, as may be readily understood, not without its influence on the passage of the Army from a peace footing to a war footing.

The mobilization of the cavalry is not so simple and easy as that of the German service, because the Russian regiments have no fifth squadron on the peace establishment, and, consequently, cannot immediately exchange their untrained horses for broken ones.[1]

A further cause of delay in the strategic movements of the Russian Army will be found in the small traffic capability of the Russian lines, as was proved by the military transport operations previous to, and during, the War in the East. On this point, the highly interesting account of the railways in "Loebell's Jahresberichte" for 1878 may be compared, and the study of this is strongly recommended to any one who wishes to discover the condition of the Army and military resources of Russia. The compiler there says:—"Apart from the network not being sufficiently close, the Russian railways "have not been able to develop any great capability for traffic for warlike "purposes, because this has been impeded by the existence of only a single "line of rails, the moderate supply of rolling stock, the long distances between "the stations, and the simultaneous peace traffic. The traffic service in peace "time is in the highest degree a simple and comfortable one;[2] the personnel, "both in the upper and lower grades, is accustomed to an easy quiet life, and "its duties are so mechanical that it might be unable successfully to deal with "unaccustomed conditions." The ground for this judgment is given with the most graphic details.

With regard to the want of double lines of rails, of the whole 21,810 kilometres of the encircling network of railways of European Russia, only the following lines are double, viz., Petersburg-Moscow; Moscow-Tula; Moscow-Koslov; and Riga-Dünaburg; besides the small branches from Petersburg to Gatchina, Oranienbaum, and Pavlovsk; from Landworowo to Wileiskaia (near Wilna), from Warsaw to Skierniewiece, and from Odessa to Rasdjelnaia.

For a concentration of the Russian Army on the western frontiers, however, none of these lines have to be considered, consequently we have exclusively to regard single-line railways, and may assume that the transport of troops from Petersburg and Moscow to Poland will take about double the time which would be allowed for similar distances according to the German calculation.

Finally, a more special factor is still to be taken into account if the readiness of the Russian Army to strike a blow is to be compared with that

[1] This is incorrect. Each Russian cavalry regiment has a depôt squadron where all horses for the regiment are trained, and no unbroken horses are kept in the ranks. See No. CIV, p. 156.—Tr.

[2] The highest rate of speed on Russian railways is between St. Petersburg and Moscow—43 kilometres, or 26½ miles per hour. Goods trains travel at less than 28 kilometres (17½ miles) per hour. On no other line does the speed exceed 39·5 kilometres (24¾ miles) per hour. In spite of the low rate of speed and the small amount of traffic, railway accidents are by no means unknown.—Loebell, 1878, p. 379.—Tr.

of the neighbouring armies. Hitherto, in the course of her recent history (since the beginning of the 18th century) Russia has never entered on a war fully prepared, and employing her whole strength. She has always carried on the operations with a part of her forces, till pressing necessity has compelled her to call up additional warlike resources. The natural result of this is the constantly recurring spectacle, that Russia commences her wars with defeats, and is obliged to pay a very heavy price for instruction before she attains success. This is apparent from the date of the first appearance of a modern Russian Army at Narva, throughout the intermittent attacks on the Prussians in the Seven Years' War, in the protracted Turkish War of the 18th century, and likewise in that of the 19th. In 1805, at Austerlitz, as in 1806–7, 1812, and 1828 in Bulgaria, 1831 in Poland, 1854–55 in the Crimea, and in 1877 on the Danube, this astonishing spectacle is reproduced, and, exactly on account of its chronic character, it is worthy of consideration and ought not to be ignored. Europe was for the most part astonished at the small display of strength with which the powerful Empire of the Czar commenced the last Eastern War. All the great expectations which were entertained after the imperious attitude of Russian diplomacy on the Bosphorus were falsified, though all the previous conditions were in favour of increased exertion. Twenty years of peace, the unchaining of the national strength by the abolition of serfdom, the introduction of universal military service, and the reorganization of the Army after the German pattern, the construction of the railway network, the long prearranged mobilization, and the six months' preparation for war of the Army on the Turkish frontiers, last of all the example of the highest energy in the conduct of war given by the German Army in 1870—all this produced no change in the usual procedure, hallowed as it was by the power of custom. The Russian Army moved against the Turks with a scanty force, which, after the first serious collision, was scattered to the winds, and whose remains only succeeded in maintaining their position south of the Danube by the help of the hitherto lightly esteemed Roumanians ; till, after two months, a second Army came on the stage, which gave a new direction to the events of the war.

But if, under the specified favourable circumstances on the Russian side, the fault censured above was committed, this may well be looked upon as an "established peculiarity," and its repetition in future may thus be expected. This fact may, in some degree, be explained by the interior organization of the Russian Empire, differing so much from that of the Western States of Europe, by the clumsiness of the governing apparatus and the above-mentioned insuperable difficulties in the way of mobilization, by the political feeling in particular districts, and by a consideration of the financial situation of the Empire.

In order now to approach the particular operations of the armies, it is necessary to lay down a definite political situation. Three different cases present themselves, under which all political eventualities may be classed :—

1st. Russia and France attack the German Empire simultaneously. Eventual interference of Austria-Hungary in favour of Germany.

2nd. Germany and Russia carry on the war alone.

3rd. Germany and Austria-Hungary, as Allies, make war against Russia.

### 1st Case.

*Russia and France attack the German Empire simultaneously. Eventual interference of Austria-Hungary in favour of Germany.*

If, in spite of its peaceful politics, the German Empire should be simultaneously threatened on both of its most important frontiers, from west and east, the opportunity would present itself for making use of all the resources

which an army organization systematically worked at for seventy years, thoroughly thought out and developed, offers for the defence of the country. First of all, the extraordinary readiness for action of the German Army would tell in favour of active defence—for the German soldier knows no other sort of defence—and in this readiness no other Power equals it. The Field Army promptly mobilized, would cast itself against that opponent who might be the most dangerously near it, *i.e.*, who might first appear in the field, fully equipped. As Russia can hardly occupy this position, it may be assumed that the principal masses of the German Army will be concentrated on the western frontier, and the first great decisive blows will fall there.

In the meantime the Russian Army will have finished its preparations, and completed its concentration on the eastern frontier of Germany. The mobilization itself requires more time than is allotted to it in Germany, but it is quite possible that the troops stationed near the frontier might receive orders to cross the German border immediately after their mobilization is completed —without waiting for the corps from the interior of Russia—or even on the very day of the declaration of war, without putting in the ranks the men called up. The large number of cavalry divisions stationed close to the frontier (2nd, 3rd, 5th, 6th, 14th, and Don Cossack Divisions) seems to point to this eventuality, and the quarters are, at least, so selected that the German territory might be inundated with them in the most diverse directions.

This invasion by isolated parties of cavalry is only a phantom, a means of terrifying a population, taken by surprise when in fancied peace, and can never be of more decisive import. The main question lies in the point or points which the Russian leaders choose for the concentration of their troops. If a glance is taken at the Russian railway system, Warsaw will first of all be seen to be a favourable rendezvous, since the great lines which lead westwards from Petersburg, Moscow, and Kiev unite there. The detrainment of the troops could also be accomplished in perfect quiet and security at this place, since it would take place behind the Vistula, with the outworks of Novo Georgievsk and Ivangorod on either side. If, however, one considers what a mighty collection of troops there would thus be in a small area, how difficult it would be to arrange for their maintenance, and further how troublesome would be the crossing of the Vistula by these masses with their columns and trains, the presumption is forced upon one that the Russian Army Corps will be assembled not at one but at several points. Besides the above-mentioned reasons this view is supported by the configuration of the German frontier, with East Prussia pushing far out towards the north-east, and by the fact that the Polish theatre of war, both on account of the small number of main roads and of the difficulties in the way of accommodating troops, necessitates a corresponding division of the forces.

If we look round for suitable places, Kovno on the right wing and Ivangorod on the left fulfil well the necessary conditions. Kovno is a concentration-point favourably situated for the III, II, I, and Guard Corps, eventually also for the IV Corps if the Northern or Right Army should be reinforced by this corps. The railway communication is secure, and to relieve the railway, the II and III Corps could eventually be assembled on the frontier by route march.[1] The V and VI Corps, and probably the IV, besides the Grenadier and XIII Corps from Moscow, could be most easily assembled at Warsaw.

Finally, at Ivangorod the Army Corps brought up from the centre and the south would reach their point of concentration, viz., the XIV, XI, XII, IX, X, and VIII Corps. These, however, could, in one case, only arrive here one after the other, since, entirely or in part, they must use the same railway line, Kiev-Lublin, and in the other case would probably be obliged to leave a

[1] II Corps: Wilna to Wirballen 120 miles. III Corps: Riga to Tauroggen 156 miles.—Tr.

considerable fraction fronting Galicia. This last eventuality will be referred to later.

The three armies thus formed have now before them as goals :—

The Army of the Right, the invasion of East Prussia, the investment and siege of Königsberg;

The Army of the Centre, the march from Warsaw in a straight line on Posen and Berlin, and the siege of Posen. Thorn must also be considered, since it blocks the only railway line available, as well as the Vistula, which would be so important for bringing up supplies for the Army;

The Army of the Left, finally, the march on Kalisch or Czenstochau and the invasion of Silesia, or to close on the flank of the Army of the Centre if this comes to a standstill before Posen.

Such a picture of the state of affairs certainly opens a very sad perspective for the eastern frontier provinces of the German Empire. We offer it, however, for consideration that the most extreme case is here set forth, and that all chances are conceded to the enemy. We turn, therefore, to the counter-measures to be adopted on the German side.

While the bulk of the German Army is drawn away to the other side, and there occupied, some army corps and cavalry divisions must be sent to the eastern frontier, though the number of these should certainly be reduced to a minimum. In this the reserve troops would have to join on the largest scale, since in this conceivably most dangerous situation, the inexhaustibleness of the numbers of troops, continually pushed up to the front by the army organization, would be capable of being brilliantly proved. In this manner a fine army can be opportunely sent forward for the protection of the threatened provinces, which, supported by the generally favourable conditions of the ground, and by the great fortresses, will sufficiently fulfil the objects of the defence. From the extent of the frontier line, and in consideration of the above-mentioned collection of the Russian Army at different points, there must also be, whether for good or ill, a division of the forces on the German side, unless East Prussia, the part most immediately threatened, should be surrendered at the outset without a struggle.

We think we must assume that on the side of Russia the operations will commence with an invasion of this province, since it protrudes so far into Russian territory, and because the entrenched camp of Königsberg, with a strong active garrison, flanks the Russian line of operations on the Vistula, and in particular sharply threatens the main étappen line Wilna-Warsaw. Furthermore, the opportunity would hardly be let slip of opening the campaign with a rapid occupation of a hostile province, a temptation which certainly the Russian national instinct would, least of all, be able to resist.[1]

In order to encounter here the attack from the general direction of Kovno, a German detached force would be stationed on the middle Pregel about the important point, Insterburg. Covered in front by the Szeszuppe, on the left by the lower course of the Memel river, and on the right by the Mazovian swamps, it appears possible here to oppose a numerically superior force successfully, or at least to hold the enemy at bay for some time. The East Prussian railway system, in which Insterburg forms an important junction, can be thoroughly utilized for the lateral movement of troops, as well as for bringing them up and withdrawing them. The assistance even of fortress artillery from the stores at Königsberg, for use within the defensive position, is not impracticable, since the direct railway communication with that place renders the transport possible. These operations find the strongest stay and firm support in the entrenched camp of Königsberg itself, which, in case of need, has to receive the Army when forced back. If the fortress is sufficiently prepared for this eventuality with regard to its equipment and supplies, it would now be in a position to play a distinguished part. Its situation in the neighbourhood of

[1] Compare Gourko's first passage of the Balkans in 1877.

the coast, and its connection with Pillau, would perhaps enable the portion of the Army hastening hither from the east not to seek shelter directly within the line of forts, but to choose a position in Samland within their sphere, so as to maintain its freedom of action, and keep open the direct communication between Königsberg and Pillau. But even if this should not succeed, the Russian Army of Invasion will, either entirely or for the most part, be held fast before the fortress and be lost for further operations, since without the possession or the secure investment of Königsberg, the carrying forward of the offensive towards the Lower Vistula is not to be thought of.

It is doubtful whether a regular siege of the fortress will be undertaken. The siege train parked at Dünaburg would at all events be made available here as speedily as possible. It can be brought up by rail to the frontier station Wirballen, but from this on, the smaller gauge of the German lines (1·435 metres compared with 1·524 Russian—4 feet 8½ inches and 5 feet English) prevents the further use of the railway. Either the transport by road of all materials over a distance of 20½ German (95 English) miles must take place, or the railway must be arranged for the broad gauge. The latter work, however, will hardly be accomplished, since it requires an alteration of the permanent way, and the laying of a new line, whose sleepers would first have to be brought up, or else demands a changing of the wagon axles.

A decidedly favourable circumstance for the defence of Königsberg lies in the direct water communication with Pillau, which keeps open free intercourse by sea with other places. If this little maritime fortress should be blockaded by a hostile fleet, water communication with Dantzig by the Haff and through the Lower Vistula would still remain open, a way which the enemy could only succeed in closing with difficulty, and then not permanently. Königsberg can thus certainly be regarded as a strong bulwark which restrains the enemy's invasion long enough for a change of circumstances to take place elsewhere in the theatre of war.

The south-east of the province of East Prussia seems to us not to be threatened ; since, as mentioned already, the Mazovian hill country with its immense quantity of woods and lakes is not suitable for military operations, and no great military road leads through this district. A glance, if only a hasty one, must, however, be given to the districts on the right bank of the Vistula. An offensive movement from the concentration area between Warsaw and Novo Georgievsk has little probability. Against it there is the want of through roads from the mouth of the Narev to the Prussian frontier,[1] but above all the difficulty of crossing the Vistula between Thorn, Graudenz, and Dantzig. Moreover, since no objective of importance would here be reached, but the main line of the operations would make a circuit, we may leave on one side the eventuality that a large army will take the offensive in this direction. But it may well be assumed that an independent corps will be detached for the investment or siege of Thorn, and will direct its advance hither. Since, however, the railway below Wraclawek runs along the west bank of the Vistula, this corps can accompany the main army as far as this point, and here first change to the other bank, and maintain lines of communication on both banks of the river.

We have thus arrived at the consideration of the operations in the theatre of war on the left bank of the Vistula. Here we are occupied with the advance of the main Russian Army in a direct line from Warsaw to Posen.

[1] In July, 1831, the Russian Army, some 40,000 strong, under Paskiewitch, experienced great difficulties in marching from Pultusk on the Narev to Plock on the Vistula, and thence towards Thorn. The distance was about 83 miles, the district was generally swampy and wooded, and only country roads were available. On account of the want of good roads and of the difficulties of supply, the troops were divided into five columns, of which one was forced to pass within about 15 miles off Modlin (Novo Georgievsk) where the Polish Army was then stationed.—Tr.

For this three great roads are available—

| | | |
|---|---|---|
| Warsaw-Sluzewo ........................ | 35 German miles | (160 English). |
| Warsaw-Slupce.......................... | 31 „ | (143 „ ). |
| Warsaw-Kalisch ........................ | 41½ „ | (192 „ ). |

The march of those troops which cannot be sent by these roads must necessarily be delayed, in consequence of the bad condition of the other tracks. Since the passage of the Vistula at Warsaw has to be taken into account, we may estimate the time from the moment of assembly of the army at Warsaw till its arrival at the frontier as at least fourteen days. The Warsaw-Alexandrovo railway can certainly be used for some detachments, but its importance must not be too highly estimated, as its rolling stock is limited and cannot be supplemented from the rear,[1] and as the detrainment must take place far from the frontier, out of regard to the sphere of operation of the fortress of Thorn.

Against the main danger pressing on from this side, the principal German forces are to be assembled on a straight line of which Posen would form the central point. The defence of the eastern frontier is plainly favoured in the province of Posen by the conditions of the ground on both banks of the Warthe, and sufficient opportunities for a rapid movement from one bank to the other are afforded by the bridges at Neustadt, Schrimm, and Posen.

On the right bank of the Warthe, in the distance of 18 German miles (83 English) between Posen and Thorn, a peculiar collection of lakes and watercourses would check a rapid advance from east to west. In the first line Lake Goplo and the course of the Upper Netze as far as Bromberg, behind this a line of lakes extending from Powitz by Mogilno to Znin, and finally the chain of lakes of the Upper Welna from Gnesen by Rogovo to Zerniki. In this district small detachments might be able to offer a long resistance at the few points of passage and defiles, and cause delay to superior masses, especially as they have close behind them the fortress of Posen, a place of refuge always ready. (Posen to Slupce 9 German miles—41½ English.) The only open spaces in this part of the frontier between the Warthe and the Vistula lie—1st, close to the right bank of the Warthe, between this and the Lake of Powitz. The Warsaw road here enters German territory, but the invader is brought straight on the fortress of Posen; 2nd, between the Netze and the Vistula at Bromberg. Here the invader's line passes within the sphere of effect of the fortress of Thorn, and he is thus impeded.

On the left bank of the Warthe, the line of the Prosna offers an immediate opportunity to make a stand against the invader on the frontier, as he, on his side, has previously to accomplish the passage of the Upper Warthe and the swampy districts on its banks. If our troops, however, should not succeed in protecting themselves behind the Prosna from being outflanked, or should fail to inflict partial defeats on the enemy by means of cleverly-delivered blows, and are consequently obliged to retreat, a similar tract of country is found in the line of the Obra and Warthe from Wollstein to Posen, when the lately concluded manœuvres may be repeated in a still more real fashion because in direct connection with the fortress of Posen.

Without reckoning on particularly favourable chances, it will have to be admitted that if the hostile invasion be thus materially hindered, the investment of the fortress of Posen can be delayed for some weeks. The German Army of the East, in case it were not in a position to prevent this last event, would endeavour not to be shut up within the fortress, but to preserve its freedom

[1] The lines on the left bank of the Vistula, Warsaw-Alexandrovo, and Warsaw-Vienna, have the normal gauge of the European railway system, and are, therefore, not in immediate traffic union with the Russian railway system.

of action by moving either to the rear or to a flank. It can assume an advantageous position against the invader directly the latter proceeds to invest Posen, as this undertaking deprives him of the greater part of his forces. In any case it will do its duty, fully carrying out the idea of active defence, and it may confidently be assumed that, by generalship, a complete change in the circumstances in this theatre of war will be brought about before the Army of the East is obliged to withdraw behind the Oder.

The want of railway communication with the rear still remains to be mentioned as a drag on the advance of an army invading from the east, since both the commissariat trains and siege material will have to be brought up by road transport from Wraclawek or from Lodz. The hardships which will thus be caused to the army will make themselves felt quickly enough.

The third line of operations still remains to be considered, by which a hypothetical third army might advance against Upper Silesia from the Upper Vistula, from Ivangorod or from Novo Alexandrya.[1]. Here lies the most vulnerable point of the whole situation which we have sketched, since the Silesian frontier-line is very extensive, is marked by somewhat inconsiderable watercourses without natural lines of defence, and in the assumed case could scarcely be defended by a separate army. The right bank of the Oder would accordingly have to be abandoned from the beginning, and the defence of the country confined to the line of the Oder with Breslau as a central point, and this, according to our proposition, should be provisionally fortified. The position of affairs in Silesia is always precarious unless support can be expected from another quarter. This, however, may be confidently counted on, as the theatre of war in Upper Silesia touches the sphere of that Power which must be taken into consideration as a third factor in an eastern conflict.

Austria-Hungary is at the present moment pledged by a Treaty of Alliance to assist the German Empire in case the latter is attacked from without. The *casus fœderis* would be all the more to be acknowledged should Germany find herself between two fires. Treaties between States are, however, concluded and then broken off, if the political motives which brought them about have changed or disappeared. But the Treaty concluded between these two Powers fortunately does not rest on personal sympathies or momentary inspirations, but is calculated for the protection of the common and mutual interests of both peoples; it is of distinct advantage to both sides, and therefore seems likely to be of longer duration than diplomatic settlements commonly represent. In the political situation here examined, Austria-Hungary will find herself compelled to take part in the struggle, not on account of the interests of her ally, but of her own. She can tolerate an extension of the sphere of Russian power quite as little towards western Europe as in the south-east of our continent. Above all, she can never allow a Russian army to occupy German territory and fix its foot firmly in Upper Silesia in the neighbourhood of her frontier. The disposition of the Slavs living in Austria, especially the Czechs, might thus become so excited as to conjure up a danger to the existence of the Empire, considering the great number of Slavs living within its borders. The utterances of the Czechs at the Slav Congress of Moscow, the sword of honour sent from Prague to General Tchernayeff, and the glorification of this man as a national hero, as well as other symptoms, give an index of what is to be expected if news should arrive at Prague that a Russian army was marching on Breslau. The interference of the Austro-Hungarian forces in favour of Germany can thus be safely assumed.

On this interference the situation at once becomes different. The favourable flank position which the Austro-Hungarian Army will, by its march into Galicia, have already taken up with regard to the front of the Russian Army on the Vistula, compels this to the choice of other lines of operations. It was

[1] Pulawy.—Tr.

calculated above that Austria might be able to assemble in first line on the Polish frontier eight army corps of three infantry divisions each, besides a corresponding number of cavalry divisions. If we retain the combination for the army corps which was then arbitrarily assumed, the following would most easily be assembled by rail:—

The 5, 2, 7, and 1 Army Corps at Cracow;

The 6, 3, 4, and 8 Corps at Lemberg.

With these, two armies might be formed, each of twelve infantry divisions of respectable strength, of which one would be ready to operate on the left bank of the Vistula, *i.e.*, for the direct protection of the German frontier provinces threatened with invasion, and the other to make a diversion on the right bank of the Vistula against Lublin and Ivangorod, or to move into Volhynia.

The first army, which would be based on Cracow, would indeed, under all circumstances, have to take the offensive, and certainly immediately after its appearance on the theatre of war would either have to advance against the Russian army already on the march for Posen, and which would thereby be forced to face the south, or else have to move against the line of the Vistula itself, in case this were not yet passed by the Russians. Of course a co-operation or direct union with the German corps available in Posen must be arranged as soon as possible.

The circumstances are not so clear for the Austro-Hungarian army concentrated in Eastern Galicia. If the assembly of this should take place immediately on the outbreak of the war between Russia and Germany, the transport of the Russian army corps towards the western frontier will be influenced thereby, and the railway Berditschev-Lublin can hardly be employed for the great masses of troops which must be brought from the south and centre of Russia, since this line runs too close along the Galician frontier. In this case a Russian Army of the South will probably be assembled in the neighbourhood of Kiev, since all the conditions of easy concentration, secure detrainment, and convenient supply are there fulfilled. The advance of this army might then be made in the direction of the Kiev-Berditschev-Radzivilov-Lemberg railway, thus always securing the communication with its base. The Austrian Army would then have the choice either of moving against this invading force, or of awaiting attack on a previously prepared battle-field. In these strategic eventualities the border districts between Volhynia, Podolia, and Galicia would witness a decisive battle of European significance.

If, on the other hand, Austria should first interfere in the struggle after the Russian armies have completed their advance to the Vistula, or even have already commenced operations against the German frontier, her best course would be an energetic attack on the right bank of the Vistula against the Russian base, *i.e.*, first of all against Ivangorod. The Russian plan of operations would thus be upset, and a completely new situation would arise. The communication with the Cracow army could be maintained without difficulty by way of the Upper Vistula, and eventually a passage to the left bank and a battle, with combined forces, against the masses of Russian troops there advancing, are not to be excluded from our calculations.

There will always remain to be considered the probable disposition of the Russian forces, including perhaps an independent army in Volhynia, against which, as it would directly threaten the province of Galicia, an independent advance would have to be made at once, in order to force it back on the marshes of Pinsk.

### 2nd Case.

*Germany and Russia carry on the War alone.*

If the German Empire is involved in a war with its powerful eastern neighbour, and the struggle is carried on without allies on either side, the

point to be considered first of all is the political situation, and the decision of the question whether the entire German forces can be assembled on the eastern frontier, or whether a part must remain on guard in the west.

The latter is, under present circumstances, the most probable solution, though the defensive strength of the German western frontier permits this portion of the army in any case to be made tolerably weak. It may thus be assumed that the two armies will meet in the Vistula country with about equal strength—fifteen to sixteen army corps. The numbers represented by the third divisions of certain of the Russian army corps will be fully counterbalanced by the reserve formations on the German side.

The second question is the direction which is to be given to the troops on both sides, and then the question of their lines of concentration. On the Russian side the advance of the army is almost imperatively prescribed by the trace of the three great railway lines leading from the interior towards the western frontier. There are again the three termini, Kovno, Warsaw, and Ivangorod, which have been already mentioned. Of these there can be no doubt, except about the first; the question being whether the Russian Head-quarters may not prefer to choose a point lying more to the south-west for the detrainment and assembly of the Army of the Right. Bialystok, for instance, might be mentioned as such a point. In this way the space over which the troops would have to be conveyed would be increased by the distance from Wilna to Bialystok, and there are also the considerations of the neighbouring German frontier in regard to this part of the line, besides which all thoughts of a Russian offensive movement against East Prussia and Königsberg would be thus abandoned, since this would be carried out more easily from Kovno than from the Narev country. But on the other hand, a concentration at this point would be supported by the nearer direct communication with the Central Army assembled at Warsaw, so that unity in the operations of both would be rendered possible.

The conditions for concentration are considerably more favourable on the German side, since, as mentioned before, six railways are available. The concentration of the army is thus independent, and can be made to fall in with the actual prospects of the situation at the time. Breslau, Posen, and perhaps Deutsch-Eylau[1] seem to present themselves as advantageous points for detrainment, for a single point cannot properly be spoken of with regard to the great masses of troops in question. How many men, however, are to be dispatched in each of these directions would depend entirely on the circumstances immediately preceding above all, on the reports as to the attitude of the enemy's forces in Poland, and as to the points chosen by the Russians for the concentration of the troops brought up by rail.

As we do not wish to play the part of counsellor to the able strategists at the head of the German Army, but only propose to awaken and stimulate attention towards an eventuality of war of this nature, it will be sufficient if the chances of one case or the other are here considered.

Germany has the principal advantage in the strategic situation, by reason of her army organization, the rapid means of bringing up her forces to a war footing, and the carefully worked out preparations for their speedy concentration at any point on the frontier where their presence may be necessary. The advantage of the initiative is thus always secured, and experience teaches what profit may be gained from this, while giving a guarantee that the same will happen in future. On the part of the Russians an attempt might, indeed, be made to invade German territory forthwith, by means of the cavalry divisions stationed on the frontier, in order to spread confusion and to interfere with the mobilization. An attempt of this nature, however, is not very dangerous, as even on the frontier the invasion would meet with opposi-

[1] On the railway between Thorn and Osterode.

tion which cavalry alone would be unable to overcome. But if some of the infantry divisions[1] stationed on the Vistula should push forward with a like object, these troops, isolated and without proper war equipment, would suffer defeat, since they would probably be speedily confronted by superior forces, and perhaps be involved in a catastrophe, which, as the first mishap at the beginning of the campaign, might be of extreme consequence.

As to the consideration whither the German offensive should be directed, the place of assembly of the hostile armies must first of all be taken into account. For this, presumptions and clever forecasts play a part as well as the amount of information available. The main effort must thus always be to seek out the hostile masses, and to bring on a decision by means of an action. The manœuvre on a large scale, which in 1866 and in 1870 secured success for the German armies, consisted in their concentric advance on a point where the decision was attained by means of their united force. In the Polish theatre of war this proceeding is directly invited by the form of the Russo-German frontier line, while on the other hand it is rendered difficult by the separation of the districts on either side of the Vistula, and the obstacles in the way of forming communications across this river. For all that, stress must be laid on this concentric action, but the armies on either side of the Vistula must each be made strong enough to engage the enemy independently, and be enabled to hold their ground, at least sufficiently long to permit the other army to hasten up and assist.

The line of offensive operations of an army on the right bank of the Vistula (in general parallel to the Mlawa-Novo Georgievsk Railway) avoids the difficulty of crossing the Vistula in the face of the enemy, whose right flank is thus sharply assailed. By reason of the objective of this army, and the importance of its task, as well as in relation to the difficulty of carrying it out, it would seem imperative to make it stronger than that operating on the left bank of the Vistula. It may be forced to form front towards Bialystok, and to fight, while it must at the same time make itself safe on the side of the Bug, and the intrenched camp of Novo Georgievsk. A direct reinforcement from the two other armies is almost out of the question.

It remains yet to be considered that the extreme north-east of the Empire, the country about Memel, must be protected against an invasion. The strength of the corps drawn up on the Pregel must be regulated according to whether a great army is collected between Wilna and Kovno, and takes the offensive, or whether merely minor forces show themselves in this direction. The assembly by Germany of any army to take the offensive in this direction would not, in our opinion, be advantageous ; as such an offensive, being in an eccentric direction, would widen the distance between it and the other German forces, would attain no important result, and in case of a reverse elsewhere, the absence of the troops to be employed here would be seriously felt. Even against a hostile army concentrated at Kovno, a defensive action with a suitable number of troops seems to be more advantageous, since a division of strength is in this way avoided, and on the other hand it may be assumed that the advance of the German armies into the valley of the Vistula will soon enough have as its effect the drawing thither of the hostile corps operating on the Niemen.

The road communications in the direction of the Bug are not precisely to be called unfavourable, at least in comparison with the former condition of the communications on Polish soil.[2] There are four roads available, viz. :—

[1] No. 4, Lomza ; No. 6, Plock ; No. 7, Radom ; No. 3 of the Guard, 8 and 10 at Warsaw.

[2] After the campaign of 1806–7, Napoleons aid that "in Poland he had discovered "a fifth element—mud."—Tr.

1. Mlawa-Plonsk-Novo Georgievsk ............................ 13 G. miles .... 60 E.
2. Mlawa-Przasznysz-Pultusk-Sierock .................... 13½ „ .... 62 E.
3. Chorzelen-Pultusk-Wyschkow on the Bug ........ 14 „ .... 64 E.
4. Mysciniec[1]-Ostrolenka-Ostrow-Malkinskaia[2] ........ 11 „ .... 51 E.

The last-mentioned road leads through the impracticable country between the East Prussian frontier and the Narev, which is covered by the forest labyrinth of Ostrolenka. To extend farther to the east is a course which would hardly recommend itself. With reference to the advance of this army, which we must denote as the main army, it is to be taken into account that, in passing from the Prussian frontier to the Bug [12 German miles (55 English) direct], it has a considerably less distance to traverse before its probable collision with the enemy than the forces starting from the frontiers of Posen or Silesia, which must march in a direct line some 30 German miles (138 English) to arrive at the Vistula. On the other hand, the passage of the Narev, and the movement of great bodies of troops in a country with so many streams and with so many military obstacles as this, may be attended with great delay. It will always be of importance to time these operations so as to agree as accurately as possible with those directed against the Middle Vistula. The fortress of Novo Georgievsk will not be without its influence. A special corps of observation must in the first place be stationed in front of it, but it will also affect the choice of a point for crossing the Bug, the invader being forced to make a wider détour towards the east. Everything else must be left to the force of circumstances.

On the left bank of the Vistula we may consider the advance of two German armies, of which the right may be the weaker, based on the line Breslau-Posen, and operating against the Vistula between Warsaw and Ivangorod. The operations depend first of all on whether the left bank of the Vistula is occupied and defended by the enemy, or whether this is from the beginning abandoned, as appearances would seem to suggest. At any rate it may be presumed that the German troops will have an absolute superiority, as their offensive movement can be commenced sooner than the great masses of troops from the interior of the Russian Empire, with all the equipage necessary for taking the field, can be assembled on the Vistula, and can have passed this river.

The passage of the Vistula between Warsaw and Ivangorod, in face of the assembled main army of the enemy, must certainly be described as a difficult manœuvre.[3] The co-operation of the Northern Army on the Bug may, however, be counted on, and the experience drawn from military history proves that the passage of a river has never been prevented for any great length of time. The Russian passage of the Danube in 1877 is the latest example, and the circumstances of this were certainly more difficult. The two armies advancing against the Vistula must weaken themselves by sending detachments against the bridge-head of Novo Georgievsk, the citadel of Warsaw, and the bridge-head of Ivangorod. The capture of the fortress of Warsaw will be a matter of the first importance in the conduct of the campaign, in order thus to obtain undisturbed possession of the Polish capital.

With regard to the communications with the rear, the following is to be noted : On the left bank of the Vistula two railways are available, which would serve as étappen lines for the German armies advancing from Thorn

[1] On the frontier south-east of Ortelsburg.

[2] A station where the Warsaw-Wilna Railway crosses the Bug.

[3] The Vistula has an average width, in this part of its course, of 500 or 600 metres (550 to 665 yards). In the German Army a divisional pontoon train can lay 39 metres (43 yards) of bridge ; a corps train 130 metres (140 yards), or, with materials collected locally, about 200 metres (217 yards). The bridging appliances of three army corps would thus be required.—Tr.

and from Upper Silesia ; and on these lines German rolling stock might be used, as their gauge is the same as that of the railway system of Central Europe. If these should not suffice, or if the considerable détour by Czenstochau should be found inconvenient, direct communication between Breslau and Warsaw might be established by laying a field railway from Wieruzow to Lodz (15 German or 69 English miles).

The circumstances are different with regard to the railways on the right bank. Both the lines, Marienburg-Mlawa and Königsberg-Graievo, are available for German rolling stock only as far as the frontier station, and on Russian territory the gauge is the wider one of 1·524 metres (5 feet). In order to be able to employ our rolling stock on this broader gauge, special fittings must be used, *i.e.*, the wagons must be unloaded and their wheels must be set farther apart for the broad gauge. For this a very roomy station is required, as well as much time and skilled labour. Let us now see what proposal is made in the article of " Loebell's Jahresberichte," which has been already quoted. " Unloading and rearranging the trains is indeed a tedious operation, but, in " consequence of the great efficiency of railway transport, it would certainly be " undertaken, if there were no other available means of utilizing, for the next " move, a railway of a broader gauge. But such means do exist ; it is only " necessary to make the gauge of the foreign line harmonize with that of our " own by relaying the metals. Major Schultz thinks[1] that this measure " appears at first sight excessively ' naïf,' but on a thorough consideration of " the circumstances which prevail in war, the question will not appear strange " whether this simple measure is not to be preferred to the alteration of the " rolling stock previously mentioned. In support of this view he then " proceeds to say, that the enemy on retreating will destroy his own railway " line, so that, before it can be used by the invader, it must be carefully examined or possibly relaid. An army in the course of operations will only be able " to advance from 14 to 20 kilometres ($8\frac{3}{4}$ to $12\frac{1}{2}$ English miles) in the course " of twenty-four hours, and the question thus is whether, within twenty-four " hours, the gauge can be changed of some 14 to 20 kilometres of a railway. " If this question can be answered in the affirmative, it appears better to " change the gauge than to alter the rolling stock to suit the foreign gauge, " since by moving the metals the most thorough conviction of the security of " the line can be attained, no adaptable wagons and locomotives are required, " there is no unloading as the trains run direct from home up to the army, and " a spacious station at the frontier becomes unnecessary.

" The possibility of quickly changing the gauge of a railway is sufficiently " confirmed by the example[2] of the Great Western and the Ohio and Mississippi Railways, and the matter does not appear to be particularly difficult. " The cross sleepers of the broad gauge railways are longer than those of " the ordinary gauge, and space for shifting the metals is not wanting. With " an army there can be no lack of workmen, and the necessary materials must " be assumed to be available, as after the gaps in the line are repaired the " traffic might be commenced with adaptable wagons. It may be further " considered that the retreating enemy will, especially on the frontier, destroy " the larger objects of the permanent way, and as the provisional restoration " of these will claim a longer time, it may be assumed that the shifting of the " metals will be completed when the temporary works are ready to be handed " over for traffic."

On the basis of this decision of experts it may reasonably be counted on that the leaders of the German Army will promptly make the broad gauge

[1] In an article in Part 6 of 1876 of the "Mittheilungen über Gegenstände des "Artillerie und Geniewesens."

[2] For a description of the execution of this work on the lines mentioned, *vide* Loebell, 1868, p. 365.

railways serviceable for military purposes. Independently of the support and maintenance of the field army, this is of special importance in the carrying out of the sieges which may become necessary in the course of the operations. To bring up a siege train against Novo Georgievsk, the Vistula can also be used, tug-boats running up from Dantzig or Thorn.

There remains the discussion of the third case, to which we must now turn.

### 3rd Case.

*Germany and Austria-Hungary, as Allies, make War against Russia.*

In case the two Great Powers of Central Europe are involved in war with the Empire of the Czar, and act in concert as allies, the mobilization and concentration of their armies will, thanks to their more developed organization and better traffic arrangements, be more rapidly accomplished than is possible under the more difficult conditions of their adversary. The plan of operations of the allies must, however, be dependent on the disposition of the enemy's armies, and this disposition must therefore be first considered.

We proceed on the supposition that the directors of the Russian military movements will employ the troops stationed in peace time on the frontiers, and especially the numerous cavalry divisions, in making hasty raids into Prussia as well as into Galicia, if it were only to disturb the Allied Powers in their preliminary measures, and in the mobilization and assembly of their troops, to create confusion, and thus to bring about the delay which they desire to cause in the commencement of the main operations. But it is also almost out of the question that such attempts could attain even trifling temporary success, since they will find at all points an opponent fully prepared, and it is not impossible that some of these corps may pay the penalty of their bold undertaking, while they will be involved in difficult situations, and have their efficiency for later operations impaired.

Apart from these episodes in different parts of the frontier, which can only be termed skirmishes, the Russian Army must in the first instance prepare itself for defensive action, since its concentration is completed so much later. The Polish triangle[1] — Novo Georgievsk, Ivangorod, Brest — is the most suitable and the safest region which could be selected for this purpose. Special precautionary measures must, however, be taken for the two lines of communication (at Bialystok and at Lutzk) since both run so closely parallel to the respective frontiers that the traffic on them could proportionately easily be interfered with by the enemy. It is then a question of a conduct of affairs, coolly weighing chances, and yet energetic in the highest degree, in order to select the position within the fortified triangle suitable to the circumstances, and to stand so firm and act so opportunely that the attack which may be expected from three sides may be met on the right spot and at the right moment. Operating on interior lines certainly ensures great and decided advantages, but it must be rightly used. Hitherto only the greatest masters of the art of war have succeeded in fully utilizing these advantages.

It is doubtful whether the Russian troops will be concentrated on the Niemen, and this must be left to the judgment of the supreme authority. But without any doubt an independent army must be assembled on the frontiers of Volhynia and Galicia, probably resting on the fortress of Michailogrod (Lutzk) for otherwise the south-western and southern Governments would be exposed, without any protection, to an invasion from Galicia.

There is little new to be said about the advance of the allied armies. It will, of course, have to be guided by the measures taken by the enemy, but,

[1] The "Polish Triangle" of Napoleon was Warsaw, Sierock, and Modlin (Novo Georgievsk). Sierock is no longer a fortress.—Tr.

in addition, will act in the manner previously mentioned. While Austria-Hungary assembles two armies in Galicia, the German troops will appear at the points which are plainly indicated by the railway system. The number of corps to be directed to each of the concentration centres depends, however, entirely on the judgment of those in chief command. In the present situation the right wing and the centre might be kept weaker, and the left wing thus proportionately strengthened, as being the main army. In order to avoid too great a collection of troops in a small space and the difficulties connected with their supply and transport, it might perhaps be considered advisable to make a turning movement, and push forward a fourth army on the line Königsberg-Graievo, which would have to effect a junction in advance with the main army. A siege train for Novo Georgievsk can also be got ready at Thorn, and at the proper time can be marched off by the right bank of the Vistula.

In the above-mentioned case the Austrian armies would hardly find employment on the left bank of the Vistula, and even the corps assembled at Cracow would be moved further to the east, and be marched down the Vistula on its right bank. A double line of operations would, however, be here unavoidable, since an attack must be made from the south against the Russian forces in Poland, while the Russian armies, which will presumably be assembled in Southern Volhynia, must be energetically driven back towards Kiev. The first-mentioned Austrian Army of the Vistula could receive additional support from the German Army of the Right, in case the latter crossed the Vistula above Ivangorod. The siege of this fortress would be entrusted to the Austrians, material being brought from Cracow, perhaps by water carriage on the Vistula.

When all opposition has been overcome in the region between the Vistula and the Bug, and the line of the Vistula is in the possession of the allies, an advance will immediately follow against the second defensive line of the Empire of the Czar, viz., the Middle Bug, with Brest Litevsk as a centre. The holding of this position will not cause much delay, since its right flank can be turned from the north, while the left flank lies completely open to the advance of the Austrian troops. Moreover, the Bug presents no particular difficulties to the passage of troops, as has been proved by many examples in the military history of Poland. The difficult nature of the country on both banks of the Bug is, however, not to be underestimated, as it has wide swampy flats, especially in the neighbourhood of the fortress of Brest, where the forest of Bialowiece, the swamps of the Upper Prypet, and those in the Government of Siedlce approach each other, and in wet weather might exert an injurious influence on the operations. The employment of the railway Königsberg-Grajevo-Brest is, however, of great importance, as this provides direct communication with the base, as well as means of bringing up siege material.

If the operations have prospered thus far, and the Poland of Congress up the Bug and the Niemen is in the possession of the allies, the great question of the direction to be given to further action will present itself to those in supreme command. In an abstract and purely theoretical way no judgment can be pronounced on this point. The factors especially concerned are the condition of our own and of the enemy's troops after the close of the campaign on Polish soil, the direction of the enemy's retreat, the season, and the state of the communications dependent thereon.

But if these factors should give a favourable result in the strategic calculation, and if the determination whither the offensive shall be further carried is an open question, the decision would then certainly be given in favour of the line towards Moscow.

This requires a closer proof. Apart from the hostile armies, whose annihilation must always be the first object of the war, two objective points lying far asunder present themselves, viz., Petersburg and Moscow. The first is the

official, the latter the national capital; the first is the seat of the rulers of the Empire and the organs of Government, the latter the centre of Russian trade, and of the industrial and agricultural Governments, and is the great junction of the railway system. Petersburg lies on the periphery, Moscow at the centre of the Empire; the first is concerned in trade with foreign countries, which in time of war is of little importance, the latter commands the internal traffic as well as that with the east.

The distances are as follows:—

From Bialystok[1] to Petersburg, 122 German miles, 560 English.
From Brest Litevsk to Moscow, 143 German miles, 660 English.

This is slightly in favour of the first line of operations, but this point will attract no attention if it be considered that united action between the German and Austrian troops is only possible in the direction of and beyond the Dnieper, since on this line the Galician railway system, which extends far towards the east, can be made available, while in the Petersburg direction the Austrian portion of the army would have great difficulty with regard to its communication with its base. The point then arises that the invading army would traverse much less productive provinces, in case of operations against the north, than would be found in the central and southern Governments of Russia. The Baltic Provinces are indeed amongst the best cultivated districts of the Russian Empire, but with regard to the amount of their produce in cereals and cattle, they cannot be compared with the wealth of the richly endowed central Governments. In the first case the invading army would be mainly dependent for supplies on its home base, while in the interior of Russia it would, in a great measure, be in a position to live on the resources of the country.

To these points may be added, finally, as a factor which turns the scale, that by a foreign occupation of the Governments to the south and south-west of Moscow, the Russian Empire would be deprived of its vital power, since its most populous districts, its granary, and the headquarters both of cattle breeding and of manufactures, would be thus cut off from it. For the prosecution of the war it would be in want of soldiers, money, and supplies, as well as of arms. But with the capture of Petersburg none of these advantages would be attained. The invading army would stand in the cold, inhospitable, and barren north country, would have behind it the Russian fleet which would support the maritime fortresses and would command the sea, and a new front would have to be formed towards Moscow. On the side of the Russians, the national war would be based on Moscow and the rich Governments of the southern part of Great Russia and of Little Russia, and would be carried on with the greatest obstinacy. A few figures may serve to strengthen the position taken up as to the capabilities of the different Russian provinces. The "Russische Revue" for 1878 contains a very instructive article on this subject by Friedrich Matthäi, called "The Importance of the several Provinces of Russia in relation to their Agricultural Productions," in which are detailed the annual returns of each Government for cereals of all kinds, an accurate enumeration of the cattle, and then a proportional estimate of the annual net value of the results of agriculture and cattle breeding. From this we have extracted the figures for the north-western Governments between the German frontier and Petersburg, as well as for those of the centre, between the Polish-Galician frontiers and Moscow. The main relative proportions of the Governments may evidently be considered by means of these figures:—

[1] Taken as being about the middle point of the new base Königsberg-Brest-Litevsk.—Tr.

*North-Western Governments.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Grodno | 703 | square | German | miles, | $24\frac{1}{3}$ | million | roubles | annual | value. |
| Wilna | 772 | „ | „ | „ | $27\frac{3}{4}$ | „ | „ | „ | „ |
| Kovno | 738 | „ | „ | „ | 30 | „ | „ | „ | „ |
| Vitebsk | 820 | „ | „ | „ | 21 | „ | „ | „ | „ |
| Courland | 495 | „ | „ | „ | $20\frac{1}{4}$ | „ | „ | „ | „ |
| Livonia | 839 | „ | „ | „ | 39 | „ | „ | „ | „ |
| Esthonia | 358 | „ | „ | „ | $7\frac{3}{4}$ | „ | „ | „ | „ |
| Petersburg | 817 | „ | „ | „ | $7\frac{1}{8}$ | „ | „ | „ | „ |
| Pskov | 794 | „ | „ | „ | $25\frac{1}{2}$ | „ | „ | „ | „ |
| Novgorod | 2221 | „ | „ | „ | $15\frac{3}{4}$ | „ | „ | „ | „ |

*Central Governments.*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Kiev | 926 | square | German | miles, | 77 | million | roubles | annual | value. |
| Tschernigov | 951 | „ | „ | „ | 36 | „ | „ | „ | „ |
| Orel | 848 | „ | „ | „ | 53 | „ | „ | „ | „ |
| Kursk | 843 | „ | „ | „ | $88\frac{1}{2}$ | „ | „ | „ | „ |
| Kaluga | 561 | „ | „ | „ | $16\frac{1}{2}$ | „ | „ | „ | „ |
| Tula | 562 | „ | „ | „ | $42\frac{1}{4}$ | „ | „ | „ | „ |
| Moscow | 604 | „ | „ | „ | $12\frac{3}{4}$ | „ | „ | „ | „ |
| Riäsan | 764 | „ | „ | „ | $44\frac{3}{4}$ | „ | „ | „ | „ |
| Tambov | 1208 | „ | „ | „ | 92 | „ | „ | „ | „ |
| Voronesch | 1196 | „ | „ | „ | 57 | „ | „ | „ | „ |
| Poltava | 906 | „ | „ | „ | $58\frac{1}{2}$ | „ | „ | „ | „ |
| Charkov | 989 | „ | „ | „ | 45 | „ | „ | „ | „ |

If some Governments of similar dimensions in the two parts of the above table are compared,[1] our view will be found to be justified. The further the invasion be pushed towards the centre, and the more it is extended towards the south, the more favourable will the chances prove. But plainly the latter course would be rendered possible by the co-operation of Austria-Hungary, and by the easy communications with the eastern provinces of that Empire. With this we repeat the proposition set forth above—Russia will be conquered not at Petersburg, but at Moscow!

It cannot be doubted that a widely extended offensive movement of this sort, with the warlike appliances of the present day, is on the whole practicable. The étappen line is formed by the railways, which up to Minsk form a duplicate line of communication with the base. Beyond this, the south-western railway system is available. An étappen line also leads from Galicia by Kiev, and this could be used further, by Kursk and Orel, up to Moscow.

The difficulty of securing the flanks, with which Napoleon had to contend in 1812, is a matter of much less importance with the broad front on which the allied armies would advance. The only apprehension which might be felt as to the left flank being attacked from the north, might be set at rest by placing a detached force of suitable strength on the Upper Dwina.

It may be assumed as a matter of course that the new base of operations—Lemberg, Brest-Litevsk, Königsberg—would be solidly organized by the experienced and cautious Generals of the German Army. In the extensive line of operations, the only fortified points necessitating a siege are Bobruisk and Kiev, and of these the latter only would affect the operations.

[1] For instance, Riäsan with 764 square German miles produces $44\frac{3}{4}$ million roubles, while Wilna with an area of 772 square miles only produces $27\frac{3}{4}$.

From these tables it appears that on the average one million roubles are produced annually in the north-western Governments from about 39 square German miles, and in the central Governments from about $16\frac{1}{2}$ square German miles.—Tr.

Many people recoil from the idea of undertaking a Russian campaign of such truly vast dimensions, and consider it impracticable because they can perceive no end to it. The catastrophe of the great French Army of 1812 has still a disheartening effect on weak minds. Many also maintain, with regard to the events of that campaign, that even at Moscow no treaty of peace could be extorted, since the distances to Petersburg on the one side, and to the Volga on the other, alone suffice to ensure a constant retreat for the Russians, and defeat for the invading army simply by time and space.

The comparison with 1812, however, is no longer applicable, since the principal difficulty in the conduct of a campaign at that period, viz., the maintenance of communication with the base of operations, is now removed, or, at least, materially reduced, by the existence of one, and eventually of two lines of railway. Moreover, an important difference is made by the circumstance that modern armies are much more thoroughly and copiously equipped than those of Napoleon could be, and that their power of cohesion is a very different affair from that of the "Grand Army," swarming with various elements indiscriminately brought together. But with regard to the operations it is also to be mentioned that now not one, but several lines of operations would be employed, and that the army would thus advance on a broader front.

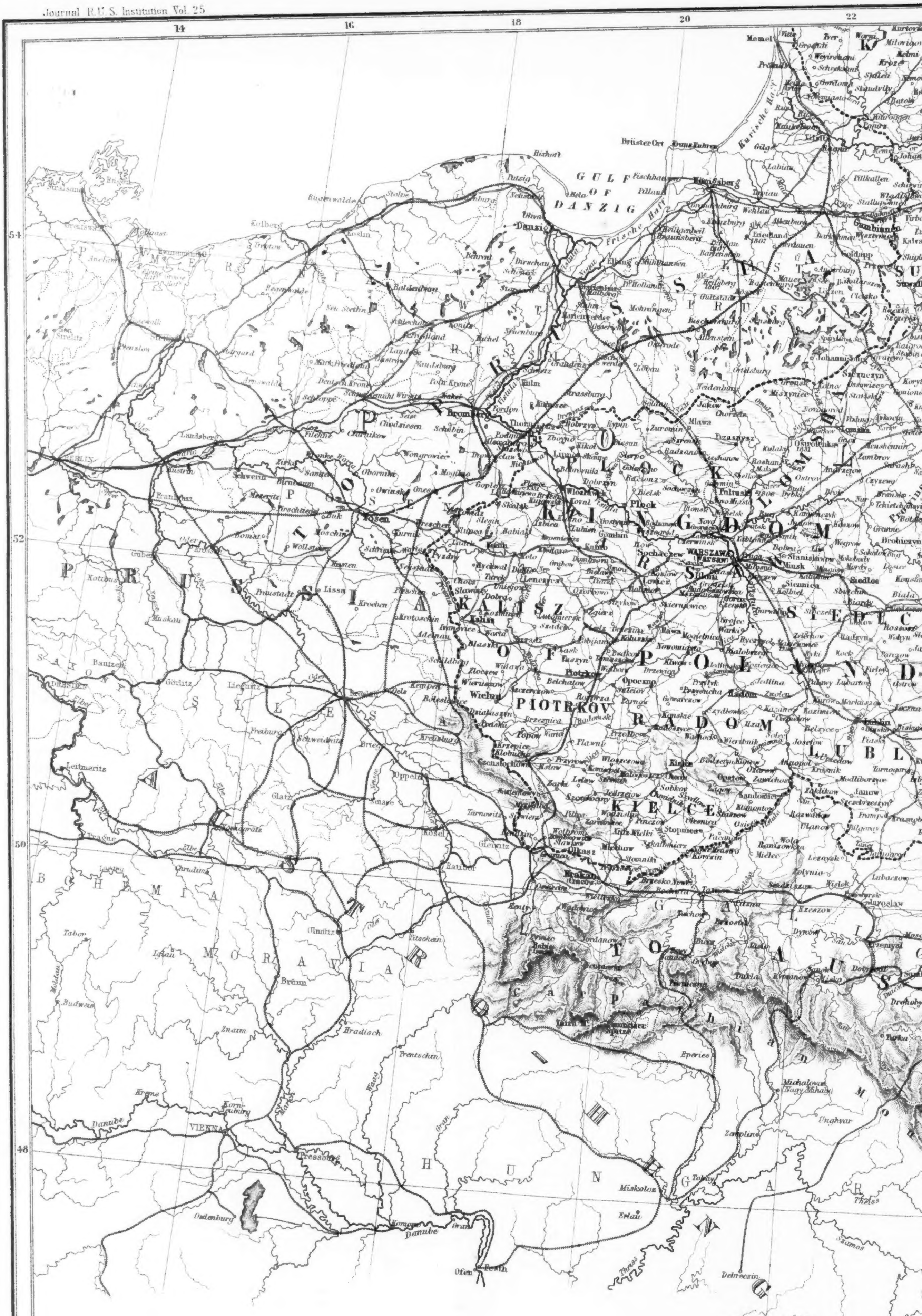
The districts which would have to be traversed have assumed a different aspect in the course of this century, and population and wealth have increased considerably. Such a carrying on of a national war as that of 1812, by abandoning the dwellings and their destruction by the owners themselves, must now-a-days belong to the domains of impossibility. Furthermore, we believe, in case events develop themselves as we have sought to explain, that the invading army will rather be in a position to bring the Russians to want and need, than the reverse; for the Governments of the Tschernosom[1] are fertile enough to feed large armies for a long time.

If the question be asked finally, what is to be the end of a war of giants of this sort, the answer must certainly be rather doubtful. We can only put forward a project with regard to this, without raising a claim to advancing anything new.

Moreover, in case Germany and Austria-Hungary come out of this war as conquerors, they must thenceforward renounce all idea of winning for themselves material advantage. Neither annexation of territory nor war contribution can be considered possible. The only remunerative result would be a driving back within its own frontiers of the great Slav Power which so strangely stands facing western Europe, and the formation of an intermediate State[2] as a passage land and connecting link between the German centre and the Slav east of the Continent. Both the allies are equally averse to enlarging their territory by annexing the Vistula country, since it can suit neither of them to increase their Slav population, especially with a nationality so strongly marked as that of Poland. The experiment would have to be made whether a Polish State, within frontiers carefully to be defined towards the East, might not be capable of existence under a Western European princely family, perhaps a cadet of the House of Hapsburg. The Poles would certainly feel themselves more attracted towards the Catholic, polyglot, and varied nationalities which unite to form the Austro-Hungarian State, than towards the strongly-marked German nationality of the neighbouring Empire.

In the event of the Polish nationality generally containing within itself the power to form and maintain a State, the prospect would be thus offered to it of a peaceful and constant development, under the protection of the two Great Powers. Germany would thus gain a bulwark against Russia, and a moving

[1] Black soil.—Tr.
[2] A scheme similar to this was suggested by Talleyrand in 1806.—Tr.




Taken from Keith Johnston's Royal Atlas Map South West Russia

350 Miles to St Petersburgh
220 Miles to Moscow
700 Miles to Moscow
KOVNO
VILNA
SUWALKI
GRODNO
MINSK
MOHILEV
SMOLENSK
WEST
RUSSIA
LITTLE
TCHERNIGOV
VOLHYNIA
PODOLIA
KIEV
LUBLIN
GALICIA
AUSTRIA
BUKOWINA
BESSARABIA
KHERSON
Marshes of Pinsk
Vitebsk
Minsk
Kiev
Lublin
Lemberg
Kishenau
Odessa
Tchernigov
Jitomir
Bobruisk
Smolensk

back of the burdensome Russian customs' line.[1] The Prussian maritime provinces would develop afresh by this opening up of their back country, new blood would thus be brought into the districts adjoining the Oder and Vistula, and Poland herself would be made accessible to culture by the establishment of communications. Germany, Austria-Hungary, and Poland, united in a customs and postal union, might not only exchange among themselves the different products of agriculture and of manufactures, but would also take a very influential place in the markets of the world.

Russia would have to bear the expense of this transformation; as, by such an expulsion from the pivots of trade of Central Europe, her status would be entirely changed, and she would then be thrown back directly on Asia.

We are now at the end of our reflections. As a result of these it follows, that on the Russians assuming the offensive, the Prussian frontier districts, and in the converse case the Polish triangle, will be the regions in which the strategic decision will be arrived at, and therefore to learn to know these better is especially to be recommended. Finally, an effort has been made to prove that, in spite of her geographical peculiarities, a war could be waged against Russia, and carried out to its final consequences, and that in this respect she does not occupy any special position different from that of other European States.

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## PRÉCIS OF THE DUTIES OF AN ADJUTANT OF A BATTALION IN THE GERMAN ARMY.

Extracted by Captain Allen, East Yorkshire Regiment, from "Der Dienst "des Adjutanten von Hauptman v. Scheel."

Battalion Adjutants are appointed on the recommendation of the Officer commanding the battalion. The Adjutant conducts the correspondence and office work of his battalion. He keeps a nominal roster for Officers, and for non-commissioned officers and men by companies.

The non-commissioned officers are under his control for practical training in battalion and other exercises; he also sees that they are correctly turned out for guard duty, &c.; he is responsible for the proper instruction of the bandsmen and buglers in the use of their instruments, and that on battalion parades they are clean and correctly dressed.

He corrects the maps which are left in the orderly room, especially with reference to chaussées, railways, canals, and communications generally. For this purpose the Landraths supply the necessary information periodically to the various district commands.

Office hours, as a rule, from 8 A.M. till noon and from 2 P.M. until the work is over.

One clerk per orderly room is allowed and one orderly who is to be a man qualified for lance-corporal.

The Adjutant supervises local returns, especially such as relate to mobilization.

More in detail his duties are—

[1] From the 1st January, 1881 (old style) an additional duty of 10 per cent. has been imposed on goods imported into Russia. As this additional tax is payable in gold, it is equivalent to an increase of about 13 per cent.—Tr.

Detailing Officers of the day.
„ „ for grand and visiting rounds.
„ „ „ guard and orderly duty.
„ „ „ court-martial duty.
„ „ „ fatigues.
„ „ „ receipt of money.
„ church parade.
„ Feldwebel[1] weekly for duty, &c.
„ non-commissioned officers for guards and duties.
„ companies for fatigues and other duties.

He dictates the orders to the Feldwebels.

The theoretical instruction of the non-commissioned officers by the battalion Adjutant generally begins on 1st October, takes place twice a week for one hour, and lasts till the commencement of his battalion drill. The subjects are—

Battalion drill.
Garrison and guard duties, arrests, patrols, &c.
Duties in police courts, courts-martial, courts of inquiry.
Elements of "Army Discipline Act."
Elements of military correspondence.
Instruction as to conduct of working parties.
Field fortification and earthworks.
Making ammunition.
Conduct in command of parties, &c.
Conduct of baggage, escorts, and fatigues.
Railway transport.
Precautions to be adopted to prevent sunstroke, &c., on the march, and mode of treatment.
Duties in camp and on the march.
Map reading and an accurate topographical knowledge of the vicinity of the garrison. For this purpose an expedition, map in hand, is recommended.
Extract from the regimental records if time permits.
Skeleton battalion drill. The band to attend to practise the cadence.

The musicians are attached to a company for discipline, rations, clothing, &c., but for duty and "musical employments" not on duty they are under a Staff Officer, an Officer who understands music, or the *regimental* Adjutant.

There is a band committee, of which the regimental Adjutant is a member.

The Adjutant is responsible for the ammunition of the battalion, and is to be present when any is received or issued.

On parade he corrects distances, dresses markers, &c., much the same as our Adjutants, and sees that the band is properly formed up for marching past, &c.

When the battalion is in half battalion columns or company columns the Adjutant simply carries orders or instructions, and acts as aide-de-camp to the battalion commander.

On the march he prepares a sketch of the road and acts as Staff Officer, map in hand. He rides forward to announce the arrival at, or probable time of passing through, another cantonment.

Details baggage guard, ammunition escort, colour party, &c., &c.

Rides on and orders the inhabitants of villages to have water ready in vessels in the street for the troops to drink.

[1] The German "Feldwebel" performs all the duties of a colour-sergeant, but is in a somewhat superior position. He ranks senior to the "Portepée-Fähnrich," and is saluted by them. His duties have been described by a German writer as those of the Captain's Adjutant.

Arrived in camp, he details the duties and receives the orders of the commanding Officer from the brigade Adjutant as to locality of bivouac.

In the field he prepares a list of casualties after an action, and keeps a diary of operations in his own handwriting.

From the foregoing notes it will be seen that in the German Army the Adjutant acts as secretary and aide-de-camp to the battalion commander, and has no such relations with Officers commanding companies as in the English Service.

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## INCIDENTS OF THE WAR BETWEEN CHILI AND PERU, 1879–80.

Contributed by Lieut. MADAN, R.N., late H.M.S. "Shannon."

### *Introductory.*

THE war between Chili and the allied Republics of Peru and Bolivia has naturally not excited much attention in England; but some details of the principal naval events which occurred will, it is believed, be found interesting to those who study the science of naval warfare; as both Chili and Peru possessed ironclads, torpedo-boats, and several kinds of torpedoes; and the former country, in addition, several recently-constructed guns.

The following notes are chiefly from accounts given me by Chilian and Peruvian Officers, from my own personal observation on the spot, from official reports, and from Chilian newspaper accounts. The Peruvian press, it should be mentioned, is quite untrustworthy.

### *Origin of the War.*

The struggle for supremacy on the West Coast of South America between the nearly related Republics of Chili and Peru had, owing to the natural jealousy which existed, been impending for several years.

Eventually a dispute arose in consequence of the desert which surrounds the badly-defined boundary between Chili and Bolivia becoming very valuable by the discovery of the existence of nitrate of soda in vast quantities.

The differences were patched up by treaty for a time, but Bolivia, urged on by a secret alliance with Peru and by her own want of money, imposed taxes on Chilian subjects contrary to the agreement.

Chili, alarmed by the warlike preparations of Peru, demanded a declaration of neutrality from her. This was refused, and Chili, though far from being prepared, declared war against the allies on the 5th of February, 1879.

### *Chilian Navy*, 1879.

1. "Blanco Encalada," 2. "Almirante Cochrane."—Sister ships designed by Mr. E. J. Reed, and built in England in 1874 and 1875. They are short powerful-looking central battery ironclads carrying six 9-inch M.L. Armstrong guns, 12 tons, besides several light guns and two Nordenfelt machine-guns. Displacement 3,560 tons, I.H.P. 2,920. Armour, 9-inch at water-line, but tapering to bow and stern; 6- and 8-inch round the battery. Twin screw, and, therefore, very handy. During the war, only the lower masts were standing with foreyard up, the tops being protected with iron shields. The bowsprit and other spars were all landed. As there was no dock accommodation on the coast for them, their iron bottoms were foul and they could only steam 9 or 10 knots.

3. "O'Higgins," 4. "Chacabuco."—Sister corvettes, 1,670 tons, 800 I.H.P., carrying three 150-pr. 7-ton Armstrong guns, and four 40-prs.

5. "Abtao."—An old corvette only steaming about 5 knots; armament, three 150-prs.

6. "Magallanes."—Gun-vessel, one 150-pr. and 2 smaller guns.

7. "Corvadonga."—Gun-vessel, two 70-prs. and 3 smaller guns.

8. "Esmeralda."—Wood corvette, built in 1854, about 800 tons.

There were also eight or ten steamers, some armed, used as transports.

*Peruvian Navy*, 1879.

Bolivia possessed no ships, but Peru claimed to have a navy at least as powerful as that of Chili.

1. "Huascar."—The well-known turret-ship, with two 10-inch 300-pr. M.L. Armstrong guns. 5½-inch armour on her turret and with a 4½-inch belt; having been docked at Callao, she could steam about 11 knots.

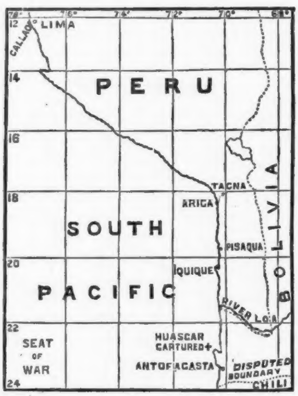
2. "Independencia."—A broadside ironclad of an old type, protected by 4¼-inch armour, about 3,000 tons displacement.

3. "Union."—A fast corvette of about 1,200 tons, having new boilers (rising above the water-line). She could steam about 13 knots. Thirteen guns.

4. "Atahualpa," 5. "Manco Capac."—2,100 tons displacement, length 235 feet. Sister harbour defence monitors, with 10 inches of iron on their turrets. They carried two 15-inch Rodman guns, smooth-bores, but their speed was under 5 knots.

6. "Pilcomayo." 600 tons. Five guns, since altered.

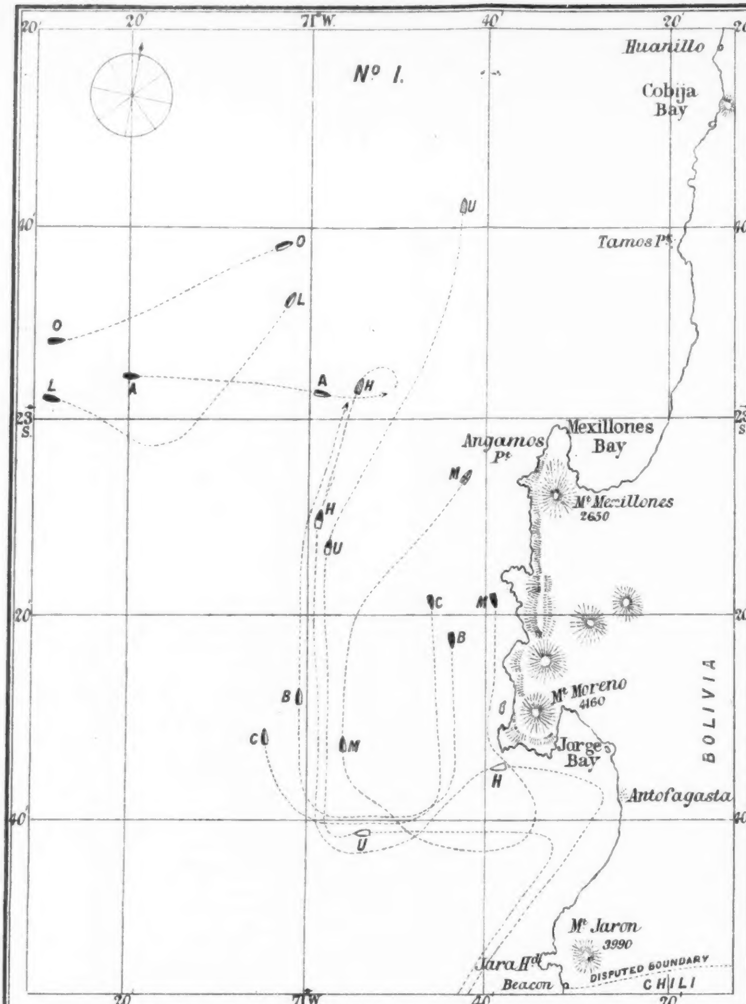
7. Two Herreschoff torpedo-boats and several transports completed the Peruvian squadron.




*Naval Engagement off Iquique.*

The Chilian squadron having completed its hasty preparations, steamed north on May 14th, with the intention of attacking the Peruvian ironclads in Callao Bay. The "Blanco" and "Cochrane" had landed all their spars, except the lower masts and foreyard. Their tops were protected by iron shields. Two old wooden vessels, the "Esmeralda" and "Corvadonga," were left behind to blockade the Peruvian town of Iquique, where the allied forces were assembling.

By a curious coincidence the Peruvian ironclads "Huascar" and "Independencia" left Callao for the south almost on the same day. They passed but did not sight the Chilian squadron, and eventually reached Iquique on the




**CHILIAN.**

A. Almirante Cochrane.
B. Blanco Encalada.
C. Corvadonga.
O. O'Higgins.
L. Loa.
M. Matias Cousino.

1st Position.
2nd "
3rd "

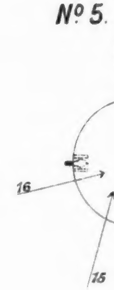
**PERUVIAN.**

H. Huascar
U Union.
1st Position
2nd
3rd

Nº 3.

Nº 4.

Nº 5.

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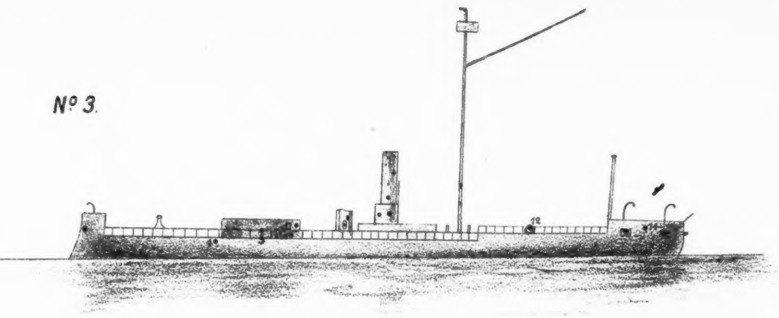

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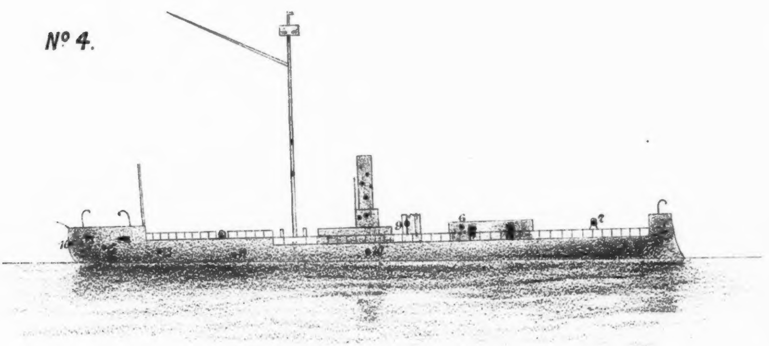

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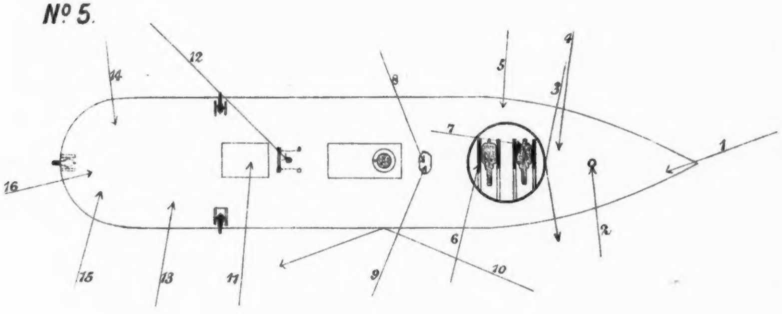



**INJURIES SUSTAINED BY THE HUASCAR.**
**8TH OCTOBER, 1879.**

, 5, Martins Lane W.C.

21st of May, at daylight. They at once attacked the Chilian vessels, and a very unequal contest ensued which can be described in a few words.

The little "Corvadonga," closely pursued by the "Independencia," steamed away south, keeping close to the coast and firing her stern gun. The wisdom of this proceeding was soon apparent as, after a chase of five miles, Captain Moore, of the "Independencia," by gross mismanagement, ran his ship on a reef, where she soon became a total wreck. The little "Corvadonga," almost uninjured, keeping up an incessant fire until the "Huascar," after sinking the "Esmeralda," appeared, coming to succour her ill-fated consort.

The fight between the "Huascar" and the "Esmeralda" is perhaps more instructive, though the latter had of course no chance against the 10-inch guns of her swift antagonist.

The "Esmeralda" commenced firing with great spirit, but soon one of her boilers burst, and she drifted almost helplessly about, a target for the shore batteries as well as the turret-ship. At last, after nearly an hour's firing, Captain Grau, of the "Huascar," determined to ram the "Esmeralda," now riddled with shot, and with many of her crew killed and wounded. The first attempt was not very successful, though the "Huascar's" ram struck the "Esmeralda's" bow; before, however, the ships disengaged, Captain Arturo Pratt, of the "Esmeralda," followed by a few men, jumped on to the "Huascar's" deck, and sold their lives dearly in the endeavour to carry her by boarding. By all accounts the same scene was repeated when the Peruvian ship again attempted to ram; the boarding party of the "Esmeralda," though larger than the first, was overpowered and all slain. The third stroke of the ram decided the fate of the Chilian corvette, and she sank with her colours still flying, most of her gallant crew perishing in the waves.

The "Corvadonga" made good her escape to the south.

*Remarks.*—The action appears to have been one in which a towing torpedo might have been used with advantage by the two Chilian vessels, as a defensive weapon.

Both were inferior in speed to their ironclad pursuers, but by keeping the torpedo between themselves and the enemy either by the use of the helm or by veering one of two towing lines as in the German system, they would at least have been protected from being rammed. It seems very questionable whether stern spar torpedoes would answer the same purpose so effectually, as they only guard a limited space, do not preserve their depth when inclined aft, are liable to be shot away and to foul the screw.

Another noticeable point is, that the only apparent chance left for the crew of a vessel that has been successfully rammed lies in their being able to grapple the enemy's ship before she disengages herself, and then to carry her (the upper deck at all events) by boarding. If this supposition is correct, it is of course of the first importance that every man on board should be armed with a revolver and cutlass, and not as we too frequently see with a cutlass only. It seems unfair that our sailors should be expected to throw themselves on the deck of an enemy (only one in every ten possessing a revolver in addition to his cutlass) to find themselves opposed in all probability to marines armed with loaded rifles and fixed bayonets, or to sailors with magazine carbines.

Another obvious remark that occurs is, that nations who choose to build their unarmoured corvettes and sloops with speed inferior to the ironclads of a possible enemy must expect to lose them.

### *Capture of the "Huascar."*

The events which occurred during the four months between the naval engagement off Iquique and the capture of the "Huascar" by the Chilian ironclads illustrate in a most striking manner the immense advantage a man-

of-war possesses in being able to steam a knot or two faster than the enemy's vessels she has reason to be afraid of.

The Peruvians, after the loss of the "Independencia" on the rocks near Iquique, had only two vessels of any power left that could keep at sea, the "Huascar," turret-ship, and the "Union," a fast corvette. Yet these two vessels were able for four months to completely paralyze the trade of Chili, and to keep the whole coast-line in a constant dread of bombardment. The "Huascar" would suddenly appear off some port, open fire or destroy property, and when the Chilian ironclads appeared, having been telegraphed for, would leisurely steam away to another part of the coast. She captured several vessels, including a transport steamer, with a whole regiment of Chilian cavalry on board. The Chilian Government were now considerably embarrassed. They were unable to send a single transport with troops or provisions to their army, on their northern frontier, without the escort of one of their two powerful ironclads, and meanwhile the whole coast-line was open to the attacks of the "Huascar" and her consort. They had no dock sufficiently large to accommodate the "Blanco" and "Cochrane;" and these vessels, with foul bottoms and 9 or 10 knots speed, could not hope to catch the Peruvian turret-ship.

At last they adopted the only plan which was really open to them. The "Cochrane" was ordered to Valparaiso; her machinery was put in complete repair, and placed in charge of English engineers; her bottom was thoroughly cleaned by divers. All this involved a stoppage of other operations for over a month, but when the work was finished, it was found that she could steam over 11 knots, and was at least as fast as the "Huascar."

The Chilian Fleet were once more collected together, and an expedition organized to proceed in search of the two Peruvian vessels, whose method of conducting operations was now pretty well understood. They were still employed in making raids on the Chilian seaports, returning when chased by the "Blanco" to the fortified town of Arica, which they used as their base of operations for coal and provisions.

The Chilian squadron, consisting of the "Blanco," "Cochrane," "O'Higgins," corvette, "Corvadonga," gun-vessel, "Loa," armed transport, and "Matias "Cousino," coal steamer, left Antofagasta on October 1st, 1879, and steamed north to Arica, about 350 miles distant, in search of the two Peruvian vessels. They arrived off the bay during the night, and immediately sent in a steam launch torpedo expedition armed with McEvoy's patent duplex outrigger torpedo. It failed, however, as the two boats left the squadron at too great a distance out at sea, and their want of speed prevented their reaching the anchorage before daylight. It was then seen that neither the "Huascar" nor "Union" were there, so the Chilian squadron, not thinking it worth while to attack the "Manco Capac," harbour defence monitor, and the "Pilcomayo," gun-vessel, protected as they were by forts mounting heavy rifled guns, steamed south again, and the following plan was arranged for entrapping the Peruvian ships, which they were nearly certain to find lying in wait off some Chilian seaport.

The plan was this. The three slowest ships were to steam south along the coast, and if, as was expected, they sighted the "Huascar" and "Union," about 15 miles from the land, they were not to give chase to them at once, but were to circle round at reduced speed, and then to drive them due north to meet the fast ships, the "Cochrane," "O'Higgins," and "Loa," who were following the slow squadron at a distance of about 50 miles, and who would engage them until the "Blanco" came up.

This rather clever piece of strategy proved perfectly successful. All happened as the Chilian naval commanders anticipated, though their scheme was nearly marred by their receiving some other orders from their Government.

After steaming south for some time, the Blanco and her consorts sighted

the "Huascar" and "Union" laying to, just out of sight of the town of Antofagasta, where the Chilian Army was being concentrated. (See Diagram No. 1.) The Chilian ships reduced speed, and soon succeeded in turning the Peruvian flank. The "Huascar" and "Union" were in a short time steaming leisurely to the northward, laughing at the apparently impotent attempts of the more powerful "Blanco" to catch them. Great was the anxiety now on board the "Blanco." Would the "Cochrane" be at the appointed distance? Should one of those fogs, so frequent on the coast, come on, the Peruvians must escape, but soon all doubts were at an end by the appearance of three columns of smoke a little on the port bow of the retreating ships.

On board the "Huascar" all was now consternation. Captain Grau, by all accounts a brave and certainly capable man, saw at once the trap in which he had been caught. Three courses appear to have been open to him.

1st. To steam boldly and meet the "Cochrane," and, though inferior in gun power, endeavour to ram her or cripple her before the "Blanco," some four miles astern, could come up.

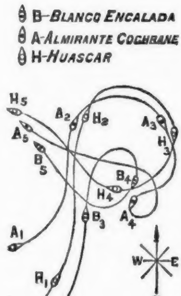
2nd. To endeavour to escape to the north-east, between the "Cochrane" and the shore, trusting to have superior speed.

3rd. To turn round and engage, or escape past the "Blanco."

Captain Grau chose the second course, though he must have heard that the "Cochrane" had been refitted, and it is a well-known fact that he had applied just before this cruize for leave to Callao to be docked, as his ship's bottom was by no means clean, but his application was refused.

The "Union" steamed quickly ahead, and escaped to the northward, but it was soon apparent that the "Cochrane" would cut off the "Huascar's" retreat.

The engagement which followed is best described by referring to the numbers on the diagram (No. 2), which was given to me by the senior executive officer of the "Cochrane."




1. Huascar opens fire at 9.25 A.M., at the "Cochrane," on her port bow, distant 3,200 yards. The fourth shell from her turret gun ricochetted and struck the "Cochrane's" bow above the armoured belt; it destroyed the galley, but did not burst. The "Cochrane" opened fire at 700 yards, the "Blanco" being about 4 miles astern. "Cochrane's" fourth shell wrecked the "Huascar's" forecastle, and shortly after a shell from the "Huascar" struck the "Cochrane's" starboard battery, but glanced off the 6-inch armour, leaving a dent.

*Remark.*—It would seem that Captain Grau of the "Huascar," after he found that his retreat was cut off, made a great error in allowing the

"Cochrane" to assume a position directly astern of him. His own guns became masked by his poop, while "Cochrane," having a projecting as well as a recessed embrasure, could bring four heavy guns to fire nearly right ahead.

2. 9.55 A.M. A 9-inch shell from the "Cochrane's" starboard foremost gun struck the small armoured (3-inch iron) conning tower abaft the revolving turret, partially destroyed it, killed Captain Grau, and disabled the steering wheel which was just below it, by exploding in the conning tower.

*Remark.*—Though the "Huascar" kept up the fire, it is very doubtful whether any Officer really took command of the ship after this fatal shell explosion, indeed it would be hardly possible, as the engine-room telegraph was destroyed; the upper deck was kept clear of men by the deadly fire of the Nordenfelt machine-guns, which the Chilians possessed, and the only means of steering was by tackles hooked and worked in the Captain's cabin below.

3. Soon after this, a Palliser shell from the "Cochrane" penetrated the "Huascar's" turret, and burst against the right trunnion of the right gun, killing most of the men, and another shell entered the Captain's cabin, destroying the steering tackles and the men endeavouring to work them. The great circle which the "Huascar" was now making to starboard is believed to have been quite accidental, as it is nearly certain that the ship was never under the control of the helm after the death of Captain Grau, although the Peruvian official reports allege the contrary.

4. The "Blanco" having arrived on the scene, fired her first shell, and in an attempt to ram the "Huascar" missed and passed astern. This proved to be a very ill-judged manœuvre, as she drove the "Cochrane" from her very advantageous position, and compelled her to put her helm hard a-starboard, and make a complete circle to avoid collision with her consort. To add to the "Cochrane's" difficulties, just as her circle was half made, a large shell (believed to have been fired by mistake from the "Blanco"), passed completely through her abaft the battery, without bursting, but still doing considerable damage, besides killing two, and wounding eight men.

Had not the steering gear of the "Huascar" been disabled, now would have been the time for escape. Her engines were still working at full speed, and she was undoubtedly a faster vessel than the "Blanco," but those on board were quite unable to use the opportunity. The fire of the Chilian ironclads was incessant, and a hail of Nordenfelt bullets completely cleared the "Huascar's" deck, and silenced the Gatling in her top. Another shell penetrated her turret, and bursting, splashed the left gun, killed the first Officer and the men who were working it.

Both Chilian ironclads were soon in hot pursuit, the "Cochrane" rapidly regaining her lost position, and soon their shells disabled the "Huascar's" steering tackles for the third time.

5. 10.55. The "Huascar's" crew, now completely demoralized, surrendered, hauling down their flag one hour and a-half after the action commenced (the engines were not stopped for some minutes after). The "Cochrane's" boat was the first to board, and they were just in time to compel the engineers to close the valves that had been opened to sink the vessel. The shell-holes were temporarily stopped, and she was conveyed in triumph to the nearest port. The "Union" escaped to Arica.

*Remarks.*—1. During the action the "Cochrane" fired 45 Palliser shell, the "Blanco" 31, and it is believed that the "Huascar" fired about 40 projectiles from her turret guns. The "Cochrane" was hit three times; the "Blanco" was untouched, but the "Huascar" was seriously injured by at least sixteen large Palliser shell, besides bearing innumerable marks from Nordenfelt bullets, and from the segment and shrapnel shell of the small deck guns.

The weak armour of the "Huascar" ($5\frac{1}{2}$- and $4\frac{1}{2}$-inch) appears on the whole

to have been worse than useless as, though it deflected three or four 9-inch shell, and resisted the smaller projectiles, yet it enabled the Chilians to dispense with fuses and use Palliser shell which burst, after penetrating, with terrible effect.

3. The great importance of having all steering arrangements below the water-line, and well protected by armour, is also shown. Three times was the "Huascar's" helm disabled, first the fighting wheel, and then the relieving tackles twice, and her after-cabin was filled with the dead bodies of those who had been endeavouring to work them, and it is remarkable that a year after her capture, while bombarding the forts of Callao, her tiller was again struck, and she had great difficulty in getting out of the range of the Peruvian guns. The policy of building ships with lifting screws would seem to be questionable, as not only is the rudder head, tiller or yoke chains, &c., above the water-line, but also the Samson posts are liable to be shot away.

4. The shot-holes in the "Huascar" were so irregular and jagged, that no stoppers were of any use. After the action large pieces of wood were placed outside, covering the shot-hole, and were secured to a bar inside by nuts and bolts.

5. Although a Chilian Palliser 9-inch shell burst between decks close to the lower part of the turret, it revolved without difficulty after the action.

6. No torpedoes of any sort were used.

*Injuries to "Huascar."*

1. Shell, Palliser, entered topgallant forecastle, wrecked it, and broke stem.

2. Struck the capstan and carried it overboard.

3. Palliser shell struck the turret, glanced off, leaving a groove in the iron about one inch deep.

4. Palliser shell entered the turret compartment below the upper deck, the port side, burst over the magazine hatch, choked the turret machinery with *débris*, but did no material damage, as the turret revolved easily afterwards.

5. Palliser shell struck the edge of the upper deck, the port side, abreast the turret, burst, splashing the turret with fragments.

6. Palliser shell penetrated the turret to the right of the right gun, making a round hole through the iron, but an irregular one through the wood backing; struck the right carriage bracket, burst, killing, it is said, all in the turret.

It is believed that this gun was not fired again, but as it was afterwards run in and out, it is probable that it could have been fired with safety with one capsquare to hold it.

7. Palliser shell penetrated the turret to the right of the right gun, near the top, at right angles to the slide, made a hole similar to 6; burst, struck the left gun, breaking the hind sights and grooving the jacket. The gun was not disabled, but the interior of the turret was much injured, and all the crew are said to have been killed or wounded.

8, 9. Struck and destroyed the captain's conning tower (3″ iron, 10″ backing); the explosion of the first disabled the fighting wheel below.

10. Palliser shell struck the ship's side abreast the funnel, and glanced off without doing any damage.

11. Palliser shell entered the engine-room, burst, killing four men on the upper platform, but did not damage the engines or hit those in charge.

12. Palliser shell struck a 12-pr. upper deck gun, knocked off the muzzle, passed on, scoring the deck, and finally destroying the main bitts.

13. Palliser shell entered the Officers' cabin, burst, doing great damage.

14. Palliser shell entered the poop.

15. Palliser shell penetrated the stern, burst, cutting the rudder chains, and killing those working the relieving tackle.

16. Palliser shell penetrated the stern, injured the stern-post, killing all on the relieving tackles on bursting.

These were the most serious injuries done, but marks of small projectiles—Nordenfelt and rifle bullets—were visible in all directions.

*Bombardment of Arica.*

A short account of the bombardment of Arica may be interesting for two reasons:—

1st. The town and forts were shelled by an armed merchant steamer, attended by an ironclad as an escort.

2nd. It was at this place, on another occasion, that a shell burst in the armoured battery of the "Cochrane" with fatal effect.

Arica, the fortified seaport of Tacna, is, as will be seen on referring to the map (p. 694), very important as the principal outlet for the commerce of Bolivia. Its partially sheltered roadstead is defended by about twenty heavy rifled guns, ten mounted on the Morro, a high cliff close to the town, and the remainder were in well-constructed forts along the beach and in redoubts a short distance inland.

Under the shelter of the batteries lay the monitor "Manco Capac," with two 500-pr. smooth-bore Rodman guns in her fixed turret, but as she was only capable of steaming three or four knots per hour, she could not attempt to steam any distance from the bay.

Very soon after the capture of the "Huascar" on October 8th, 1879, the Chilian Government sent some vessels to blockade Arica. Their navy was now strengthened by three additional vessels—the "Huascar," which was soon repaired and sent to the north; the "Pilcomayo," a gun-vessel captured by the "Blanco Encalada" in November, 1879; and the "Angamos," a fast merchant steamer, which had been purchased in Europe by the agents of the Chilian Government. On her arrival at Valparaiso she was armed with one long-range heavy gun, an 8-inch B.L. Armstrong, $11\frac{1}{2}$ tons, 18 feet 4 inches long; this was mounted in an ordinary carriage, on a central pivoted slide, which turned on a circular cogged racer placed in the centre of the ship before the mainmast. Two large openings in the ship's side allowed the gun to be fired about 15° before and abaft each beam, and its great length ensured the muzzle projecting over the ship's side. Four men could traverse the gun from one side to the other in about a minute after the gun had recoiled in. The deck, of course, had been strengthened.

On 27th February, 1880, the "Huascar," now flying a Chilian flag, arrived to assist in the blockade of Arica, and a short action took place between her and the "Manco Capac." After an attempt to ram the monitor, which failed (it is said through the engine-room telegraph not acting), a round shot from the Peruvian vessel killed Captain Thompson of the "Huascar," and she was compelled to withdraw, though neither ship was injured.

Two days after the "Angamos" arrived, and immediately opened fire on the monitor and forts at the extraordinary range of 8,000 yards. The effects of the bombardment were soon apparent. The inhabitants fled to Tacna, the troops withdrew inland, and the men who manned the batteries lay helplessly behind their entrenchments, unable to pitch their 300-lb. projectiles much more than half-way to the "Angamos."

Her projectiles were striking the ground close to the forts, sending up huge clouds of dust, and the shell which did not burst could be seen ricochetting a mile inland. The bombardment continued for six days, and on the 6th of March the "Angamos" withdrew, having fired over 100 projectiles at ranges from 6,000 to 8,000 yards.

Not much damage was done, as the town was built for the most part of sundried mud bricks which the shots went clean through, and for the same reason the shell, though they did great damage in bursting, did not set fire to the town.

Neither ship nor gun was injured in the slightest degree.

*Remarks.*—The lesson to be learnt is of course very apparent. Unless the great seaports, both at home and in our colonies, are defended by guns having as great range as those of our possible enemies, they are practically defenceless if our ships are for any reason absent.

The other event which is worth a detailed account of, during the long eight months' blockade of Arica, is the effect of a shell explosion in the armoured battery of the "Cochrane."

The Chilian Army, having fought and won the battle of Tacna, advanced on Arica, sending in a summons to surrender. This was refused, and the Chilian authorities, wishing to avoid more bloodshed, ordered the "Almirante Coch-"rane," which ironclad was, with two corvettes, blockading the bay, to bombard, in the hope that the defenders would see the uselessness of further resistance.

Accordingly the vessels took up positions about 3,000 yards from the forts, and opened fire with common shell, using battering charges.

The "Cochrane" is a central battery ironclad, carrying six 9-inch 12-ton M.L. Armstrong guns, identical with those in the English service. (The armament is being changed to B.L. guns at the present moment.) The two foremost guns look out of recessed embrasures, and can fire in line with the keel on each side. The next two look through projecting embrasures, and can be fired from nearly right ahead to 35° abaft the beam; the two after guns, also in embrasures, fire right aft in line with the keel to about 5° before each beam. The battery looks roomy and light, and it is important to note before proceeding that before going into action a very large hatchway between the two foremost guns and all the coaling shoot lids in the upper deck were opened to give free exit to the smoke.

After firing her port guns for some time, the "Cochrane" steamed round and opened fire from the two starboard foremost guns at about 3,000 yards. The foremost gun having been fired, the Nos. 3 and 4, after sponging the gun, were in the act of entering a 50-lb. charge of pebble powder when a 7-inch shell from the forts entered the port and burst against the front part of the slide. Nos. 3, 4, 6, 7, powder man and the gunner, who was superintending, were knocked down, and the fire from the shell ignited the battering charge. The gun and the gun's crew were enveloped in flame, the extra powder man was blown down, and the lid of his Clarkeson powder case (though he maintains it was properly on) was knocked off, and his charge also ignited, burning the whole of the crew of the port foremost gun and filling the battery with smoke and flame. All was now confusion, the other guns' crews, nearly suffocated, scrambled out into the embrasures gasping for fresh air. Men, fearfully burnt and scorched, ran madly about, and although the ship immediately steamed out of range, it was over five minutes before order could be restored and the battery doors opened. Seven men were killed, and twenty-one so severely burnt that few, if any, could serve again. The gunner, though severely burnt, owes his life to the fact that he was dressed in serge, while the men were in a white working dress. The serge resisted the fire, but the white duck frocks that the men wore were burnt completely off their backs.

After this disaster the "Cochrane" withdrew altogether, though not damaged at all by the explosion, but one of the corvettes was so seriously injured by a shell from the forts, that she had to be beached in another harbour to prevent her sinking.

Arica was taken by assault two days after.

*Remarks.*—1. By all accounts the amount of pebble powder actually in the "Cochrane's" battery at the time of the explosion was 600 lbs. in battering charges. What would have happened if all had exploded it would be impossible to say, but it seems very probable that if there had not been a large open hatchway just in rear of the gun for the flame to make its escape

upward more cartridges would have ignited, and all the 100 men in the battery would have lost their lives, and the ship would have been seriously injured. Two or three plans might be suggested to prevent such an accident as this: 1st. It would seem advisable that all powder and shell should be kept on a deck below, and should be passed up as wanted through a supply scuttle, either just in rear or on the left of each gun. 2nd. Steel traverses fitted between the guns would prevent the flame from injuring the next gun's crew. 3rd. Armoured boxes for holding the powder might be constructed near each gun.

2. It may be noticed that this accident could hardly have occurred if the gun had been a breech-loader, as then the gun and carriage would have been exactly between the shell explosion and the charge when it was entered.

3. The "Cochrane" was fighting at a 3,000 yards range. How much greater is the danger of an accident like this occurring at close quarters, especially in these days of machine-gun fire! Our iron port lids are no protection against a Nordenfelt or Hotchkiss bullet, and one of these on penetrating a cartridge case is certain to ignite the powder.

## Blockade, Bombardment, and Torpedo Operations in the Bay of Callao.

Callao, the populous and, until lately, flourishing seaport of Lima, from which city it is distant about eight miles, is built on a low sandy point stretching out into the Pacific. A fine bay, about four miles deep by seven across the entrance, is formed on the northern side of the point by the off-lying rocky island of San Lorenzo, and here, in April, 1880, sheltered from the constant southerly wind and swell, lay several Peruvian and foreign men-of-war, with a large number of merchant ships crowding in and around the commodious docks which have recently been constructed.

Callao is strongly fortified on the sea side. The shore is lined with batteries. Two 1,000-pr. smooth-bore Rodman guns on the point command the narrow channel between the mainland and San Lorenzo, and twelve other batteries, including two revolving armoured turrets, protect the town. In these were mounted eighteen or twenty heavy guns—500-pr. Rodman and 300-pr. M. L. rifled guns, by Armstrong, Blakeley, and Vavaseur, besides a large number of 32-pr. smooth-bore guns, which had done good service in beating off the Spanish fleet in 1866.

The island of San Lorenzo was left quite undefended, and of this fatal omission on the part of the Peruvians the Chilian squadron took full advantage during the long ten months that the blockade lasted.

The only vessels that now remained of the Peruvian Navy were the "Atahualpa," a low freeboard harbour defence monitor, with two 500-pr. smooth-bore Rodman guns, mounted in a 10-inch iron turret, a formidable vessel, but now only capable of steaming three or four knots; the "Union," a fast corvette, mounting twelve guns with two Gatling machine-guns. This ship was now the only one dreaded by the Chilians, as, with her superior speed, she was capable of playing the part of an "Alabama," and of doing great damage on the Chilian coast while their squadron was absent in the north; several steam-transports; a Herreschoff torpedo-boat; and several large steam-launches, armed with boats' guns and Gatlings, complete the list of the Peruvian squadron, and these all lay close to the docks, protected by a half-circle of spars, moored a short distance from the ships.

The Chilian army having been safely landed for an attack on Tacna and Arica, the squadron leaving the "Cochrane" and a corvette to blockade Arica, steamed 600 miles farther north, to establish the blockade of Callao and its adjacent ports. It was composed of the following vessels:—

1. "Blanco Encalada," flag-ship of Admiral Riveros, already described as a

short, powerful, twin screw ironclad, carrying six 9-inch 12-ton M. L. Armstrong guns of old pattern, in a central battery, protected by 8- and 6-inch armour-plates. She was fitted with a small electric light, placed on the bridge, between two Nordenfelt guns.

2. "Huascar," now flying an enormous Chilian ensign. Her 10-inch M. L. Armstrong guns had been repaired, and two new 40-pr. B. L. guns, of recent construction, capable of ranging over 6,000 yards, had been placed on her quarter-deck. She was also fitted with an electric light.

3. "Pilcomayo," the Peruvian gun-vessel, of 600 tons, captured by the "Blanco," in November, 1879, and now armed with two 6-inch B. L. Armstrong guns of latest pattern, just received from Europe.

4. "Angamos," the small armed merchant steamer, which had done such damage at Arica. She still carried the 8-inch 11½-ton B. L. Armstrong gun, of which great things were now expected.

A transport, with coal, and two torpedo-boats, the "Janequeo," a 22-knot Yarrow-built boat, and the "Guacolda," American 15-knot boat, completed the squadron.

The Chilian Admiral in command of the squadron sent to Callao determined to make an attempt to sink the "Union" before his ships could be seen from the Callao forts, and a torpedo-boat expedition was therefore organized on the way north.

The 22-knot Yarrow boat ("Janequeo") was armed with three of McEvoy's patent duplex outrigger torpedoes, one on a boom, which could be rigged out through a collar on the stem by a small steam-engine, and the other two were on side-swinging booms.

The 15-knot American-built boat, the "Guacolda," carried two similar torpedoes on booms lying fore and aft on the gunwales, ready to be rigged out on the ordinary English plan.

The squadron approached the land after dark on April 9th, 1880, and at 8 P.M. the two torpedo-boats, convoyed by the "Huascar," left the squadron and steered in for the land. The "Guacolda," having stopped to make some repairs to her machinery, lost sight of the "Huascar" and "Janequeo" in a fog, and being unable to find them again, proceeded alone, and was the only one successful in finding the anchorage. The turret-ship, with the "Janequeo," steered in the fog too far to the north, and only entered Callao Bay after daylight the next morning.

The "Guacolda" reached the anchorage shortly after 4 A.M., and, the morning being very dark, her approach had not been observed. Unfortunately, just before reaching the ships, she came into collision with a fishing-boat, and one of her torpedo-poles was broken. However, the two fishermen were seized, and, being threatened with death, pointed out where the "Union" lay. The "Guacolda" then proceeded and, after a narrow escape of a collision with an American man-of war, was suddenly brought up by the booms which protected the corvette. Concealment was no longer possible, so the remaining torpedo was exploded under the booms, and the "Guacolda" beat a hasty retreat amid a storm of musketry and Gatling fire, which, however, did her no harm. The "Union" escaped with a severe shaking.

Two remarks may be made on this bold but unsuccessful torpedo attack.

1st. Had the Chilians possessed, and known how to use, the Whitehead torpedo, there is little doubt that the "Union" would have gone to the bottom, for the "Guacolda" was able to explode her outrigger at the short distance of 12 or 15 yards from the side of the corvette before her crew, who were all armed and keeping watch, could fire a shot.

2nd. The effect of this expedition was to establish such a wholesome dread of torpedoes in the breasts of the Peruvians that the next morning the "Atahualpa," "Union," and all the transports were hauled into the docks and so fenced in with booms that they could not move out to use their guns.

Daylight revealed the presence of the Chilian fleet at the entrance of Callao Bay, and soon a steam-pinnace was seen approaching the shore with a formal notification of blockade from Admiral Galvarino Riveros, in which he gave ten days for neutrals to leave the town and harbour before he should commence hostilities.

Then ensued a general exodus, and by the given day the bay was quite empty, and only the troops who manned the batteries and people of the poorest class were left in the town.

On April 22nd the first bombardment took place. The Chilian ships steamed out from under San Lorenzo and placed themselves in position for opening fire, the "Huascar" and "Pilcomayo" at about 6,000 yards and the "Angamos" at 8,000 yards.

The flag-ship "Blanco" was unable to take part in the engagement without going within range of guns that could easily penetrate the 9-inch armour round her water-line; so, with her six 9-inch 12-ton M.L. guns, she remained in rear with the coal transport and did not fire a shot.

At 2.15 P.M. the "Huascar" opened fire with her 40-pr. long-range deck guns (her turret 10-inch guns could not range beyond 5,000 yards, and so were not used at all), and was soon followed by the "Pilcomayo" and "Angamos," the object of their fire evidently being the destruction of the ships which were sheltered behind the dock walls.

The Peruvians were not slow in replying from all their batteries, but it soon became evident that though some of their guns appeared to have 20° or 30° of elevation, few of their projectiles ranged more than 5,000 yards, and these fell into the sea with such a large angle of descent that no ricochetting was observed.

The Chilian fire on the whole was very accurate though a swell was rolling into the bay. Their projectiles (generally common shell) could be seen striking the water inside the docks, and those that went beyond were heard crashing into the town, where on bursting, they did considerable damage. The action continued the whole afternoon. Eighty-one projectiles were thrown by the Chilian ships, the Peruvians replying with 127. The upper works of several of the Peruvian ships were damaged, some houses wrecked, and ten or twelve people killed, but beyond this no serious consequences resulted from the Chilian fire.

At 5.30 the attacking squadron withdrew and renewed what soon became a monotonous blockade.

During the day-time the Chilian squadron lay quietly at anchor under the shelter of San Lorenzo, the smaller ships taking it in turn to remain on guard in the middle of the bay.

At night all weighed and stood out to sea, keeping a sharp look out for Peruvian torpedo-boats, and also for the "Union," which ship, it was rumoured, intended to escape.

In night blockading work, the Chilian torpedo-boats proved themselves extremely useful, and indeed, without them, the ironclads could not possibly hope to prevent the "Union" making her escape in the darkness: but these fast and almost invisible boats could remain unnoticed within a mile of the docks, and, besides being dangerous antagonists themselves, would have signalled to the ironclads if they observed any movement of the Peruvian corvette. Of course, the perpetual fine weather and constant light southerly winds which prevail on the coast of Peru enabled them to leave the ironclads without any dread of a gale springing up and preventing their return, so that in other parts of the world the use of torpedo-boats for blockading work would be attended with considerably greater risk than on the present occasion.

Both the "Blanco Encalada" and "Huascar" had been recently fitted with electric lights; these were occasionally used at night, but being of inferior

power were practically not of much use. It was obvious, however, that a powerful light, capable of showing the docks distinctly at a distance of four or five miles, would have been extremely useful in preventing the escape of the "Union." It would, also, have rendered a night-bombardment possible, and, though the light would undoubtedly show the position of the ship using it, yet the approach of Peruvian torpedo-boats would be discovered and signals could have been made to their own boats, which were usually four miles closer to the town than the ships outside the bay.

### *2nd Torpedo-boat Expedition.*

The two Chilian torpedo-boats proceeded, on the night of April 23rd, to destroy a mark that had been placed in the bay near the docks, at a certain distance, for assisting the Peruvian artillery to estimate the range. According to the report of the Chilian Lieutenant in command, the two boats encountered a large Peruvian decked steam-launch, armed with two small guns and carrying a number of soldiers. The "Janequeo" (Yarrow boat) at once attacked her, and endeavoured to place one of her side-swinging boom torpedoes under her bottom, but the darkness and the smoke of the Peruvian boat prevented the Chilian Officer from estimating the distance correctly, and the explosion (by electrical means) only had the effect of shaking her severely. Before another attack could be made, the troops on the dock walls opened fire, and the Chilian boats had to retreat under a heavy fire, which, however, did them no serious injury, though several mitrailleuse projectiles went through them, wounding one man.

### *2nd Bombardment, 10th May,* 1880.

The Peruvians now began their attempts to sink some of the blockading ships with torpedoes, and, with this object in view, launched some floating mechanical torpedoes (constructed on McEvoy's plan of a vibrating weight releasing a trigger) in the Boqueron Channel, where the current would naturally carry them north to the Chilian ships. They were, however, discovered next day by the Chilian ship on guard, near the centre of the bay, and were eventually destroyed. The Chilian Admiral, in retaliation, ordered a new bombardment.

The Chilian squadron had now been reinforced by the arrival of the "O'Higgins," a corvette of 1,700 tons, and carrying nine M. L. Armstrong guns of old pattern, and the "Amazonas," an armed transport carrying one long-range 6-inch B. L. Armstrong gun of latest pattern.

At 1 P.M. on May 10th, the "Blanco" and "O'Higgins" made a combined attack at the 1,000-pr. battery on "The Point," at a distance of about 4,000 yards. After some very narrow escapes from the "Rodman smashers" (balls 2 feet in diameter) they had to withdraw without dismounting the guns or doing much damage to the earthworks, though some forty soldiers were killed and wounded. The other ships bombarded from positions beyond the range of the Peruvian guns, until the "Huascar," venturing closer in, in order to use her turret guns, was struck at the water-line by a small shell, which penetrated, the water filling a wing compartment. Two or three more struck her, cutting two shrouds; one fell on the poop, and passing through it and through the upper deck into the Captain's cabin, cut the tiller ropes. The "Huascar," with difficulty, steamed out of range, but was able to continue the action with her long-range 40-prs. from a safe distance.

Most of the Peruvian ships were hit, but the dock walls, now surmounted with a breastwork of sand-bags, preserved them from serious injury as on the first occasion. As the Chilians confined their fire to the ships, very little damage was done to the town, but several boats, barges, and one brigantine inside the docks were sunk.

At sunset the Chilians withdrew.

Two more bombardments took place on May 27th and 29th, but as they were out of range of the Peruvian guns, and were very similar to the previous bombardments, a description of them is unnecessary. The Chilians, beyond keeping the Peruvians in a constant state of alarm, only succeeded in sinking a coal hulk and a small sailing man-of-war sloop, which, though close to the "Union," were more exposed. These bombardments certainly served to illustrate the enormous advantage of a nation possessing a superior artillery to that of a possible enemy, and the misfortunes of the Peruvians show plainly the danger of being behindhand in taking advantage of trustworthy inventions and improvements in the science of warfare.

Another remark may be made. It is often urged that breech-loading ordnance are too complicated for the average man-of-war's man, and that the great point gained in a muzzle-loading system is simplicity.

Without entering into the arguments on the subject, here is the spectacle presented to us of comparatively untrained and uneducated Chilian sailors, many of whom only left their fishing nets to man the fleet at the commencement of the war, working with apparent ease, and certainly without any accident, the most recently constructed breech-loading guns, after a very short training.

It may here be mentioned, that the Chilian Army possessed several batteries of Krupp field 12-prs., which, with their long range and great accuracy (I witnessed some remarkably good target practice on shore at Arica, at a 4,000-yard range), enabled them to commence their principal battles with an artillery fire, which demoralized to a great extent the Peruvian soldiers long before they, with their short field guns, were able to return it.

*Loss of the Chilian Torpedo-boat "Janequeo."*

The only event of note which occurred during the month of June, 1880, was the loss of the valuable Yarrow-built 22-knot torpedo-boat belonging to the Chilians. Many accounts have been given of this, so that the cause is still uncertain, but the following details may be interesting :—

The Chilian torpedo-boats "Janequeo" and "Guacolda" already described were cruizing as usual one night about a mile from the docks. At 1.30 P.M. they suddenly encountered three large Peruvian guard boats. These steamers, originally small screw tug vessels, had been armed with two or three boats' guns or mitrailleuses placed on their decks. Each carried about thirty soldiers, but were not fitted with torpedoes of any sort.

On seeing the Chilians the Peruvians attempted to escape, opening fire immediately. The "Janequeo," returning the fire with rifles, quickly overtook the Peruvian boat "Independencia," and made an attempt to place her stem outrigger torpedo; this failed, and the "Janequeo" then made an attempt to use her starboard side-swinging boom torpedo.

Up to this point all accounts are materially the same.

Lieutenant Senorét of the "Janequeo" states that two explosions occurred, one from his starboard torpedo which sank the "Independencia," and another from a hand charge thrown by the Peruvians on to his deck, which exploded and injured the side so much that the water began to pour in.

Lieutenant Goni of the "Guacolda," some little distance astern of the "Janequeo," heard only one explosion, which caused a large amount of smoke; he afterwards picked up the survivors of the crew of the "Independencia."

Lieutenant Galves of the "Independencia" states that, assisted by another Officer, Dr. Ugarté, he threw a hundred pound case of powder on the deck of the "Janequeo," and that, the detonating fuse burning slowly, he exploded it by firing his revolver at it, sinking both boats.[1]

[1] This account has been thought by many Officers to be very improbable, as the

The Chilian Admiral having heard the evidence of the survivors, including that of the English engineer of the "Janequeo," gave his opinion that though some attempt may have been made to throw a hand charge, yet the real cause of the accident was that in the excitement of the moment the firing key of the "Janequeo's" torpedo was pressed down when the boats were so close together that the boom could not swing out, and that the sides of both boats were blown in by the one explosion. There is little doubt that this is the true explanation.

The result of the explosion was that the "Independencia" sank at once, and most of her crew were drowned, eight only being saved by the "Guacolda." The valuable "Janequeo," though kept afloat for about ten minutes by her watertight compartments, gradually sank through their not being perfectly watertight. Her crew reached the Chilian squadron in a small boat they were able to steam to before sinking.

The "Guacolda" returned uninjured, as the firing appears to have done little or no damage to either of the combatants. The other Peruvian boats escaped.

*Loss of the Chilian Armed Transport "Loa."*

Pierola, the President of Peru, having organized a Torpedo Corps, consisting chiefly of foreigners, recommenced his attempts to sink the Chilian ironclads. An ordinary coasting sailing boat was filled with fresh vegetables and fowls, and under these provisions was placed a box containing 300 lbs. of dynamite. It was so arranged that on some of the provisions being removed a spring or trigger would be released, causing the dynamite to explode. The boat was set adrift in the middle of the bay; her sail was loosed, and she had the appearance of having recently broken from her moorings. Their plan succeeded perfectly. Although the Chilian spies had warned Admiral Riveros that an attempt would be made to destroy the Chilian vessels by explosives concealed in a boat, and although orders on the subject had been given to the commanders of the Chilian vessels, yet Captain Peña of the "Loa" appears to have paid no attention to these warnings.

On the 3rd July, 1880, the transport "Loa," armed with five guns, one being a valuable 6-inch breech-loader Armstrong gun, was on guard in the centre of the bay. Her look-out caught sight of the sailing boat drifting out to sea not far from the neutral vessels. She steamed after it and lowered a boat to tow it alongside, and then, in spite of warnings from his Officers, Captain Peña gave orders to clear the boat of her cargo. Those on shore were anxiously watching the result, when suddenly there came a tremendous explosion, and the "Loa" was completely hidden from sight by smoke and spray.

When this cleared away the ship was seen sinking with her side blown in, and in a few minutes she sank, leaving 150 men struggling in the water. About fifty men, some terribly burnt and wounded, were picked up by the boats of the neutral ships, but at least 100 perished, among whom was the Captain, who by all accounts was mainly responsible for the catastrophe.

*Attempts to Destroy the "Union."*

The next event worthy of notice was the attempt of the "Angamos" to sink or destroy the "Union" with her 8-inch breech-loader Armstrong gun. On four consecutive days she steamed to a position ascertained by cross bearings to be 8,000 yards from the docks, and from there she leisurely fired from twenty to twenty-five shells every day with remarkable accuracy. The people of Callao became so accustomed to this daily target practice that crowds would assemble about 300 yards on each side of the corvette in perfect safety to

high speed of the "Janequeo," and the arched construction of her deck, would prevent any case lodging upon it.

watch the effect of each shell, the forts, of course, being quite unable to reply to the fire.

Several of the "Angamos's" shell exploded in the sand-bag wall which protected the Peruvian corvette, and the docks themselves suffered severely from the Chilian projectiles, but beyond this and the sinking of another hulk and of two steam guard boats which had ventured out a considerable distance with the view of driving the "Angamos" from her position, no serious injury was inflicted.

### *Loss of the "Corvadonga."*

The fate of the "Corvadonga," a small Chilian gun-vessel of about 400 tons, on September 13th, 1880, was very similar to that of the "Loa." She carried two 70-prs. and three smaller guns, and though a useful little vessel was chiefly valued as the only trophy the Chilians possessed of the Spanish war in 1866. The following details of her loss by an explosion of dynamite are from the lips of a survivor:—On September 13th she was engaged in blockading the harbour of Chancay, about 30 miles to the north of Callao, and entering the port she opened fire on a railway bridge, which, however, she did not succeed in destroying. While in the bay those on board caught sight of two boats at anchor, and a boat was lowered and sent to destroy them. One, a lighter, was sunk, but the other, a particularly well fitted up lifeboat gig with oars and boathooks complete, cushions, &c., was towed alongside the "Corvadonga." A carpenter was sent in to examine her, but no explosives could be found. Unfortunately the bow and stern air boxes were not examined as there was no opening to them, and this negligence proved fatal. Captain Ferrari determined to appropriate her for his own use, and ordered her to be hoisted up to the starboard davits abreast the funnel; accordingly the tackles were hooked on to the chain slings which apparently came up through pipes in the air boxes, and the order was given to hoist. Immediately the after fall was hauled taut a tremendous explosion took place. The starboard side of the ill-fated "Corvadonga" was crushed in, her foreyard fell with a crash, the starboard boats were blown to atoms, and in a few minutes the ship sank in 10 fathoms water. The dingy was swamped, but fifteen men managed to escape in the gig, the only boat uninjured, and, though closely pursued by boats which immediately pushed off from the shore, they succeeded in reaching the blockading squadron at Callao. Forty-nine men were taken prisoners, but at least the same number perished in this disaster.

It is, of course, believed that the air boxes were filled with dynamite, and that the chain slings, instead of being attached to the keel, were secured to the pull-off of a trigger; but it is right to mention that, in some official despatches that afterwards fell into the hands of the Chilians, it is stated that the "Corvadonga" was destroyed by a Lay torpedo (the Peruvians possessing some of that description of locomotive torpedo), but it is for many reasons a most improbable story.

The Peruvians were now in a deplorable condition. Tacna and Arica had been taken, and their army there utterly routed; the "Manco Capac," one of the two harbour defence monitors, unable to escape from Arica, was sunk by her own Officers to prevent her falling into the hands of the Chilians, and one of the Herreschoff torpedo-boats, of which no use had been made, which was also at Arica, met a similar fate.

The Chilians, on the other hand, were preparing an army of 30,000 men for a final attack on Lima, with which they hoped to close the war. The "Cochrane" joined the squadron off Callao, which had also been reinforced by the "Princesa Luisa," a small iron steamer of about 120 tons, converted into a gunboat carrying three guns. A new Yarrow torpedo-boat, the "Frezia," similar to the lost "Janequeo" in nearly every respect, and two new Thornycroft steel steam-launches which had been fitted up with one outrigger torpedo

and one Hotchkiss machine-gun each on their arrival at Valparaiso from England. The "Frezia" and "Guacolda" were also fitted with one Hotchkiss gun each, and it was soon seen that they were admirably adapted for use in boats.

The Chilian Government, having proved to their own satisfaction that Sir W. Armstrong's recently constructed breech-loading guns were infinitely superior to any description of muzzle-loading ordnance, now changed the "Huascar's" armament.

Immediately after her capture, plans of her turret were sent to Europe, and two guns similar to the "Angamos's" guns, 8-inch 11½-ton breech-loaders, were ordered. These arrived at Valparaiso at the end of August, and in less than two months the "Huascar" again joined the blockading squadron with her new guns ready for use against the Callao forts.

*Attempt to destroy the Ironclads.*

On the 13th of October another attempt was made to destroy the Chilian ironclads.

Admiral Riveros having protected the anchorage under the outer point of San Lorenzo, where the squadron, with the exception of the corvette on guard, anchored during the day, with a floating boom constructed of masts chained together, the Peruvians soon saw that drifting torpedoes would be of no use, so another plan was adopted.

A large framework enclosing seventy barrels of powder was secured under a lighter, and the whole arrangement was towed to the usual anchorage of the "Cochrane" during a dark night and there moored. By means of clockwork mechanism connected to some method of lighting the powder, the whole seventy barrels were fitted to explode at ten minutes past nine, about two hours after the ironclads would in the ordinary course of events return to their anchorage.

It drifted, however, during the night a short distance, and the "Cochrane" having passed it, ordered a small gun-vessel to fire at the lighter at a short distance. This, however, she did not succeed in doing, being afraid to approach the apparently empty boat; but further trouble was saved by a tremendous explosion, which took place at the appointed time. No damage of course was done.

*November*, 1880.

No events of importance occurred during this month. The "Huascar" accidentally rammed a transport which had to be beached for repairs, and on the 3rd she tried her new guns for the first time, throwing a shell into the centre of Callao at a range of about 7,000 yards, and a few more at the 1,000-pr. battery on the Point.

It was on this occasion that the first accident occurred to the new breech-loaders which were now carried by most of the Chilian vessels, but it was one that would happen to any kind of gun. The compressor (of the ordinary Armstrong type with plates and bars) was not sufficiently set up, and the gun recoiled in with great violence when fired with the 90-lb. charge.

The woodwork and buffers in rear were completely wrecked, and about a fortnight elapsed before the gun could be again fired.

*December*, 1880.

The month commenced with a sharp torpedo-boat action. At daylight on the 6th, the "Frezia" and "Guacolda," cruizing in the bay, caught sight of the "Arno," one of the extemporized Peruvian gunboats, of about 30 tons displacement, carrying two small guns, one in the bow and the other looking over her stern. She appeared to have twenty or thirty men on board.

The "Arno" being at least $2\frac{1}{2}$ miles from the docks, the two Chilian boats were soon rushing along at a tremendous speed to intercept her, keeping up a rapid fire with their Hotchkiss guns.

The "Arno" at once retreated, opening fire with rifles and from her stern gun. The Chilian boats gained rapidly, but the Peruvian steamer being able to steam about 10 knots, succeeded in getting under shelter of the forts, which in their turn opened fire on the Chilians. They still advanced, firing the dangerous little 1-lb. Hotchkiss shell, frequently driving the men who were endeavouring to work the "Arno's" guns to shelter themselves behind the funnel casing.

At last the fire from the shore, now lined with troops, became too heavy, and the Chilian boats, though reinforced by a Thornycroft launch with another Hotchkiss gun, beat a reluctant retreat, with several of their men wounded and their sides covered with bullet indentations. Whilst steaming out of range, the "Frezia" was hit by a small shell, which went completely through her stern. Had she been properly put together no serious result would have followed, but her after bulkhead was not watertight, and before she could gain the shore she sank in ten fathoms, her engineer being drowned. What damage was done to the Peruvian vessel could not be ascertained, but apparently nothing very serious. It is probable that, had the Chilians succeeded in coming up with her, she would have been captured by simply having her deck cleared of men by the Hotchkiss fire; as it was, her guns were of little use, the crews being frequently driven from them, and when they were fired, it was evident that little or no aim was taken.

The other boats escaped to the blockading squadron which approached to assist their torpedo-launches.

The "Frezia" was raised in a few days, and was in working order again by the end of the month.

A few remarks may be made on this action.

1st. Though constructed of very thin steel, very few bullets from the "Arno" and from the troops on the beach seem to have penetrated, though the indentations were numerous.

2nd. Whatever the merits of the respective machine-guns may be, there can be no doubt that the method adopted of mounting the Hotchkiss machine-gun is admirably adapted for boat service. The complete absence of cogged wheels not only enables the gun to be turned round through all the points of the compass in about two seconds of time, but also allows the aim to be kept constantly on the target by simply bending or straightening the knees, as the motion of the boat caused by a short sea necessitates the muzzles of the barrels being raised or lowered. Those who have any practical experience the working of the cogged wheel elevating and training gear of the Gatling gun, mounted in a boat, know that when there is any motion, it is quite impossible to keep the gun aimed at an object.

3rd. The method of sighting the Hotchkiss gun (a fixed upright sight with small cross bars at the different distances) appeared very suitable for fast torpedo-boat service. As the "Frezia," when steaming at an average speed, covered 100 yards in 10 seconds, it would have been obviously impossible to have altered an ordinary clamping tangent sight as necessary, if the gun was being fired.

### *Bombardment with "Angamos's" Gun.*

After a silence of three months, the "Angamos" renewed her efforts to sink the "Union," but her daily bombardment was brought to an abrupt close by an extraordinary accident to her gun. Attended by a corvette she steamed to her usual position at a distance of 8,000 yards from the "Union," and opened a slow deliberate fire from the Armstrong gun, using the 90-lb.

charge with 180-lb. common shell. Twelve rounds were fired on December 9th, the shell striking all round the "Union," and twelve more were fired on the next day, and this time the "Union" was hit, a shell passing through the side by the waterway, burst in the water. On the 11th she again opened fire, and fired five rounds with great accuracy with $12\frac{1}{2}°$ elevation on her sights, but on the gun being fired the sixth time it suddenly shot to the rear out of its trunnion ring, and after striking the rear part of the compressor-bars a tremendous blow, it cleared 8 feet of deck, and, killing two men on its way, disappeared through the opposite side of the ship into 24 fathoms of water. The slide was quite uninjured with the exception of the compressor-bars. The carriage, which had not recoiled at all, was also uninjured, while all that was left of the gun were the trunnions and trunnion coil, and these lay in their place secured by the capsquares. The gun's crew, with the exception of the two who were in rear, were only slightly scorched. The "Angamos," deprived of her only means of offence or defence, now beat a retreat.

### "*Herreschoff*" *Torpedo-boat Expedition, January* 3*rd*, 1881.

The great secrecy with which the Peruvians conducted their torpedo operations prevented many details of their last attempt to sink the Chilian ironclads from being known. The following is all that could be ascertained :—

The "Herreschoff," double-ended torpedo-boat, had hitherto not been made use of, but now she was conveyed by rail from Callao to Ancon, a port about 15 miles from Lima. She was launched, and on 3rd January was seen to leave the harbour after dark. The next morning at daylight she was seen entering the bay again with two objects in tow, which, it is nearly certain from the description given of what showed above water, were Lay torpedoes. It was then given out that she had been sent to destroy the Chilian ironclads, but that on account of the darkness they could not be found. That expedition was her last, as a few hours after her return, the Chilian corvette "O'Higgins" and the torpedo-boat "Frezia" suddenly appeared and steamed in to reconnoitre.

Catching sight of the "Herreschoff" boat, they at once opened fire and gave chase. The Lay torpedoes, it is believed, were sunk ; at any rate, the "Herreschoff" was run on shore and deserted by her crew and was soon battered out of shape by the guns of the "O'Higgins."

The middle of January witnessed the close of the blockade and the entire destruction of the remains of the Peruvian Navy.

A well-organized army of about 30,000 Chilians attacked an equal number of Peruvian soldiers in strongly intrenched positions near Lima, and in the two battles of Chorillos and Miraflores completely routed them. The Chilian soldiers entered Lima in triumph, but before they could occupy Callao, the garrison evacuated it, blowing up most of the forts with dynamite.

The "Atahualpa" and "Union" steamed out of the docks ; the former was sunk and the "Union" set on fire and, deserted by her crew, drifted on the beach an utter wreck. The transports and gun-vessels were also burnt to prevent them falling into the hands of the victorious Chilians ; and so, as every vestige of resistance had disappeared, the war came practically to an end.

# GENERAL SKOBELEFF'S INSTRUCTIONS FOR THE RECONNAISSANCE AND BATTLE OF GEOK-TEPE ON THE 17TH JULY AND 30TH DECEMBER, 1880.

Translated from the "*Revue Militaire de l'Etranger.*"
By Captain J. C. DALTON, R.A.

WHEN General Skobeleff was summoned to take command of the Russian expedition against the Akhal-Tekkes, the public mind was exercised as to how he would be likely to acquit himself of a task which so many others had failed to accomplish, and what means he would take to ensure success.

The conditions of Asiatic are so different from those of European warfare, that the tactics of the latter must necessarily be greatly modified to suit the former; and it is interesting to know what were those adopted by the young hero of the Russo-Turkish War on this occasion. We therefore reproduce from the "Invalide Russe" of April 16th, 1881, a *résumé* of two sets of instructions given by General Skobeleff to the troops of the Trans-Caspian expeditionary force—the first on the 17th July, 1880, when on the point of reconnoitring the road to Geok-Tepe; and the second on the 30th December following, when on the eve of attacking that stronghold.

The peculiar nature of Asiatic warfare has for long attracted the attention of Russian Officers: Colonel Kostenko, amongst others, has treated this subject at some length in a work on Turkestan. We would do well to compare the principles he lays down with those recommended by General Skobeleff, and we ought to be able to extract from both much that would be useful to know in case of expeditions of a like nature.

## I.—INSTRUCTIONS FOR THE 17th JULY, 1880.

" From information received from my spies, I know that the Tekkes have " resolved to direct night attacks against the Russian troops as soon as the " latter commence to march on Geok-Tepe.

" *Officers in Command.*—Their decision as regards this was made long since, " and has not been changed; it is therefore our duty to take it as settled, and " act accordingly.

" Aware as I am of the experience and bravery of the Officers who com- " mand the troops under my orders, I remind them that, if I were not con- " vinced of their extreme energy, I should not consider myself justified in " undertaking a reconnaissance of Geok-Tepe.

" I remind them of the necessity of taking every possible measure to secure " safety; and each day, having in view the encampment for the next day, " they must study all the roads leading to the position that has been selected, " also ascertain the points that are favourable for the assembling of the com- " plete tactical units, and assure themselves finally whether it is possible for " the troops occupying such points to move forward on the offensive. Before " night sets in, they must examine the country round, not only with the " object of ascertaining the dispositions that would be necessary for the " defence (which will be settled by the Staff), but in such a manner that each " Officer shall thoroughly know the ground in front of that occupied by his " own command, and that he shall above all know the means at his disposal " to communicate and unite with the fractions on either side of him. I par- " ticularly call attention to this last point, because experience of night attacks " has proved how difficult it is to direct the fire, even perpendicularly to the " front, and firing in any other direction invariably leads to men shooting " their comrades, and to endless confusion, unless the Officer commanding the " fraction, his Officers and non-commissioned officers, have carefully studied " the position by daylight.

" *Non-commissioned Officers.*—It is as well to remind this class of the important part they play in modern warfare. I consider it just as important that they should be informed in detail of the general state of affairs, as that I should communicate it to the Officers.

"The non-commissioned officers will afterwards, in the presence of the Officers, and in a language that can be easily understood by the rank and file, give the same explanations to their men, in order that they may all assist towards attaining the desired object, by intelligently carrying out all that is required of them.

"Every reasonable being requires things to be explained to him; but where a mass is concerned, it is necessary, in addition, that the chiefs should have as much patience with, as they have love for, their men.

"I desire to draw attention to the utility of establishing conventional signals, well known to all, and which indicate distances exactly. I suggest that bonfires, large enough to burn all night, should be used as signals. In general, I consider it a very good plan to surround the camp entirely with great stacks of wood, prepared during the day, and which could be lit at nightfall. Vedettes and small picquets would be stationed behind these bonfires.

"In the interior of the camp, on the other hand, no fires must be lit beyond what are absolutely necessary, and these must be extinguished in case of attack.

" *Troops generally.*—During any engagement I recommend the troops of all the three arms not to develop the full power of their fire, unless they are forced to do so by the obstinacy of their enemy.

"Consequently, when fighting in daylight, the infantry and artillery, and the cavalry as well (when fighting dismounted), should only employ their best shots at long ranges, and, except in case of need, I insist that only those who are the best shots should be selected.

"Again, if the enemy continues to advance, I recommend volley firing, except in the case of the artillery, who will act independently. But if the enemy cannot hold together and disseminates, then the commanders of companies and squadrons may permit temporary independent firing on the condition that they order 'cease firing' the moment it becomes unnecessary.

"Even in European wars it is most important to observe the foremost groups of the enemy: it is not really the mass of individuals present on the ground that decides the victory, but the progress which, thanks to different circumstances, a few brave men may make, advancing in isolated groups. Consequently one must ever pay attention to the appearance of groups of this nature, and direct on them, by means of volleys, the full power of one's fire, for if one neglects to inflict great losses on them, these groups increase in size in a wonderful way and decide the affair in their favour.

"As we have to deal with a fanatical mob without organization, I counsel the chiefs of all fractions to keep a watchful eye on the appearance of these advanced groups; there is not a doubt but that, in annihilating them, we destroy (in the germ) all the initiative force of the rest of the mass. That is why I cannot too strongly urge on commanders to have the fire of their men under command; and in order that this grand maxim may be reality and not merely empty words, it is necessary that each commander of a unit should '*know how to make the hearts of his soldiers beat in unison with his own*' before the battle.

"He must have his troops completely in hand at the critical moment of the action, and they must be in his hands an instrument which serves him to express with a supreme energy, his thoughts, will, and feelings.

"Though in a battle by day, success is obtained by the *gradual* and rational utilization of the ground and resources at our disposal, circumstances

"may so happen during the night, that it may be necessary to produce the "maximum effect with *one single blow*. This is why, in night actions, we "should always adhere to volley firing.

"We must remember that, at night, all judging distances is illusory; it is "also of the first importance to keep impressing on the men to aim low.

"*Artillery.*—I have too much confidence in the artillery under the command "of Colonel Verjbitzki to lay down rules for its employment in action; I only "recommend that its fire should be concentrated when the opportune moment "arrives and that the nature of the projectile should be carefully selected. "This last point is of paramount importance in this country, where the great "number of small walls renders shrapnel shell with percussion fuzes quite use-"less. I beg Colonel Verjbitzki to pay particular attention to the value of "mitrailleuses when arranging for the defence of bivouacs, as they produce an "irresistible effect when they are worked at ranges which have been measured "beforehand.

"*Cavalry.*—I again impress on the cavalry all that I said before to them "before quitting Bami: and in all the engagements they may have before "them, I specially draw their attention to the coolness necessary when "fighting dismounted; and to the importance of volley firing."

## II.—Instructions on the 30th December, 1880.

"The corps which took part in the reconnaissances of the 18th July, and of "the 16th, 23rd, and 24th of December, are acquainted with the enemy and "know how to fight him. But to-day our column contains some troops who "have not yet seen our adversaries; it is therefore indispensable that they "should be made acquainted with the following conditions under which we "have to fight.

"Each undulation of the ground will be desperately contested; our enemy "is brave and excels in individual combat. He shoots well and has excellent "swords (*armes blanches*). But he fights in no regular order, and in isolated "groups, paying but little heed to the wishes of his leader; and conse-"quently he is not well suited to act and manœuvre in organized bodies.

"Although many circumstances, as, for example, the distance and nature of "the theatre of war, condemn us to be inferior in number to the enemy, still "we are constrained to take the offensive.

"Owing to the weak effective strength of our columns, we are unable to "employ the same dispositions for battle as are used in Europe. In the open "country, long deployed lines are constantly threatened by the enemy's "cavalry, which is very brave, very well mounted, and understands the use of "its weapons perfectly.

"*Infantry.*—On the contrary, infantry well massed, even without regularity, "but ardent, vigorous, and understanding how to use their weapons to the "best advantage, will, if they await firmly the hand-to-hand attack, end by "establishing the chances of the contest in their favour. We may take this "maxim as a fundamental one in Central Asia, '*Compact order is all-*"'*powerful.*'"

"Again, in the enclosed part of the country when fighting against an "enemy intrenched on a position covered with gardens, buildings and small "walls which he has fortified at his leisure and to which he attaches a special "moral importance, firstly on account of his successes last year, and secondly "because the families of the defenders are collected there with their property, "we shall have to overcome an obstinate resistance behind each shelter. We "must in fact engage in a desperate contest against the knife and yataghan.

"In cases when the enemy's masses may suddenly appear, then those de-"ployed lines which are so flexible and in which the troops move about easily "in the hands of the commanders, resolving themselves into small isolated

"groups, independent of one another and of the commanders, do not oppose "to the enemy that strength which is obtained from regular formations, from "that fire discipline so intimately connected with the latter, and from that "mutual support of the groups to one another. The *ensemble* of these "principles applied with decision and discernment '*constitutes the essence of* "'*our tactics in Central Asia*,' and gives us the right to rely on victory, in "spite of the great number of our adversaries.

"We will beat the enemy by using against him arms that he does not "possess, we will profit by our discipline and by our rifles. We will beat "him by employing compact formations (supple and manageable), by our "accurate volleys, by our simultaneous efforts, and by the points of our "bayonets, always terrible in the hands of men whom discipline, sense of "duty, and the shoulder-to-shoulder contact have soldered together to form "this great and powerful body which we call a column.

"The charges of the enemy's cavalry will be received by executing, if "necessary, a change of front to the desired direction, and by delivering "volleys at a short range. I recommend also the formation of squares, even "by battalion, if circumstances allow.

"Against an enemy advancing to attack, commence the volleys at a range "of about 500 yards, but do not lose sight of the fact that volleys are still "very effective, even at greater distances, on compact masses, whether they "be stationed in open ground, or even hidden behind walls or parapets. In a "case of this kind, one might commence firing by volleys at ranges of 3,000 "paces, by raising the sight to its full extent and aiming at the top of the in- "trenchment or wall, should the enemy be behind these obstacles. A plunging "fire of this kind, which is very effective up to 3,000 paces, should never be "undertaken by a less unit than a company, and it behoves the commander "to control it most carefully.

"*Artillery.*—The artillery should be placed in accordance with the following "rules:—The mitrailleuses will accompany the troops in the same manner as "the regimental guns used to, in order to support the infantry directly.

"The other guns will be kept provisionally in reserve, in order to be em- "ployed simultaneously, when opportunity offers; this will increase the "efficiency of the artillery, by concentrating the fire of a number of guns "under one command.

"The artillery will not quit the reserve without my order, but the choice "of position and object to be aimed at will be left to its own immediate com- "mander. The famous saying of Souvaroff, '*Artillery should pass anywhere* "'*it wishes to*,'[1] must be ever borne in mind, not alone by the commander of "that arm but by those who command the troops to which it is attached, but "only up to the moment when '*the solemn hour for the attack*' sounds.

"In this supreme moment the artillery must absolutely lose all thought for "itself, and be prepared to sacrifice itself entirely to support its comrades. It "must at all hazards precede the attacking troops, and thereby by means of "its fire, which is so terrifying at close quarters, shake the courage of the "enemy.

"Then all purely technical considerations must be laid aside. In these "decisive moments '*the artillery must have a soul*,' for the gunner is not "simply a mechanic (*sic*).

"The artillery must allow itself to be destroyed, if necessary, to ensure the "success of the attack, as absolutely as the infantry sacrifices itself when it "rushes on the enemy. The troops charged with the duty of protecting the "artillery will not abandon it. If the guns are lost, no disgrace is attached "to the artillery but to the corps supporting it.

"*Cavalry.*—The cavalry will be entirely in reserve up to the moment when

[1] In the sense of being allowed perfect independence in selecting positions, &c.

"circumstances admit of its being employed in masses. It must not be frittered away in individual encounters against the numberless mounted men of the enemy, who have excellent horses and are accustomed to use their weapons from childhood.

"Except when the enemy's cavalry is disorganized, makes a mistake, is embarrassed by some obstacle, or in a defile, &c., our cavalry must avoid encountering it mounted.

"To pursue the Tekke cavalry when retreating would be useless and would cause us to break that tactical union in which lies our greatest strength. When charging, the cavalry must keep close order, which it should be impossible to break, whether in column of regiments or squadrons.

"In charging, rapidity is less important than order, and maintaining the touch (*botte-à-botte*); consequently, except of course in the case of exceptionally favourable circumstances, these charges should not be pushed too far, in order that the men may be kept well in the hand of the commander, and that the blow may be strong and effectively delivered.

"In one word, the fundamental principle of tactics for our cavalry when acting against that of the enemy should be, extreme prudence and circumspection.

"On the other hand, it is an entirely different matter when dealing with the confused undisciplined masses of infantry as are generally found in Asiatic armies: the cavalry will then charge thoroughly and with the utmost energy; though here again the intelligent boldness of this arm must be supported by the échelon order of battle, and the concentration of the reserves rightly understood and applied; and finally when the collision takes place, by the use of the lance and the *chachka*.

"*General Rules.*—I again remind everyone of the necessity to take the strictest measures to ensure the safety of the camps before Geok-Tepe. The commanders of advanced posts must satisfy themselves of the importance of the roads leading to the bivouacs, and of the points at which the enemy can assemble in masses to attack.

"Each commander of a unit must study the zone of ground in front of him, and arrange in his own mind in what manner he can best assist those on each side of him in case of attack; for, I repeat, in the art of affording mutual support has always lain, and will always lie, the secret of victory. The ground in our front must be thoroughly studied, and the ranges and distances must be carefully measured."

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# NOTICES OF BOOKS.

*The Duties of the General Staff.* By Major-General Bronsart von Schellendorf, Chief of the General Staff of the Guard Corps. Translated from the German by Captain W. A. H. Hare, R.E. Vol. II. London: C. Kegan Paul & Co. 1877. Price, 7*s*. 6*d*. Size, $8\frac{1}{2}'' \times 5\frac{3}{4}'' \times 1\frac{1}{4}''$. Pp. 308. Weight, $1\frac{1}{4}$ lbs.

A NOTICE of the first volume of this work appeared in No. XCIII, vol. xxi of the Journal. The translation by Captain Hare, R.E., of the second volume has recently been published, and every word of it is worth reading. In it are dealt with, the Composition of Armies, Ordre de Bataille, Distribution of Troops, the War Formation of the German Army, Office Duties in the Field, Marches, Rest and Quarters, Supplies, Maintaining the Fighting Efficiency of Troops in the Field,

Special Reconnaissances and Special Duties of Officers of the General Staff in the Field during Operations. In the preface, General v. Schellendorf writes—"While "I have striven to use to the best advantage all that I have learned from a study "of the art of war, and from my own experience on active service, I have through-"out refrained from adducing illustrations drawn from military history. It is a "well-known fact that almost any assertion or recommendation can be supported "by superficial arguments founded on military history. But in order to satis-"factorily demonstrate the justice of an opinion on the ground of experience, it is "requisite not only to adduce a great number of examples of a similar nature, but "to prove that in all of them both the cause and effect are approximately the same. "* * * * Similar reasons have induced me to avoid illustrating the work with "the solution of given examples of a typical character. These examples are, in "fact, in themselves of less value than those drawn from military history. They "do more harm than good to those who have not grasped the spirit of the matter, "and do little to encourage untrammelled mental activity."

It would seem here, however, that the General is somewhat confusing the use of examples, whether actual or imaginary, as illustrations, with their use as proofs in support of some dogmatic assertion. Illustrations are absolutely necessary, in some cases, to enable men to understand the application of abstract principles; and the value of even typical illustrations must be apparent to those who have had fresh fields of practical interest opened to them by works of the character of Hugo Helvig's "Tactical Examples." An incidental advantage derived from General v. Schellendorf's contempt for examples is found, however, in the compensating fact that this work, one of the most valuable of its kind ever published, is of reasonable dimensions. It will be noticed by those who read the book, that the last paragraph in it contains a few brief but emphatic remarks on the mode in which a Staff Officer should carry out his duties, and that in these remarks the importance of the exercise of "Tact" occupies a prominent place.—H.

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*Proceedings of the Royal Artillery Institute, Woolwich.*[1]

*Royal Engineer Institute Occasional Papers.*[2]

THERE is among Officers in the Army a tendency, not unnatural in itself, to regard matters connected with any arm of the Service, save that to which they themselves belong, as things with which they have no concern. The result of this notion is that, even among military readers, literature which bears the impress of a specialité on the cover is seldom looked at by others than the specialists more immediately interested in it. Hence the valuable publications whose titles are at the head of this notice are well nigh unknown save to Artillerists and Engineers. Although hardly to be recommended as part of an Officer's travelling kit, they should certainly find a place in the libraries of all Garrisons and of Military Institutions. Among the articles of general interest in the three numbers of the "Artillery "Proceedings," issued during the current year, will be found exhaustive "Notes "on Armoured Defences," by Colonel Inglis, R.E., in which the author—1st. Traces the experimental stages through which the question of iron defences has passed. 2nd. Gives an account of the materials used in these defences and of their manufacture. 3rd. Describes some of the principal iron works set up for the defence of our naval arsenals and ports at home, and of our fortresses abroad. Some excellent drawings accompany the notes. Captain Turner gives an interesting account of the German Imperial Manœuvres of last year. Lieutenant Lloyd gives his experiences of the Defence of Ekowé, and Lieutenant Grierson a translation of extracts from the diary of a Russian Artilleryman in the Shipka Pass. For those who take interest in the technical details of artillery, horse, field, or garrison, these "Pro-"ceedings" are invaluable. We hope to find space in the next number of this

[1] These can be obtained by an annual payment of fifteen shillings in advance.

[2] These can be purchased at Stanford's, Charing Cross, London.

Journal for some remarks on the R. A. I. Gold Medal Prize Essay, 1881, by Captain Jocelyn, on the "Equipment of Field Artillery," a question of great importance, and on other papers of a technical character.

The latest issue of the "Royal Engineer Institute Occasional Papers," vol. v, 1880, is one of great interest, being a very full and complete monograph of the Siege of Plevna, by Captain G. S. Clarke, R.E. The work is not written from a technical point of view only; although there is in it plenty of valuable information connected with Field Engineering, it forms a compendium of nearly all that is known in connection with that remarkable struggle.—H.